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Single Eye Plantings as an Aid in Selection

Some of the most important varieties of sugar cane have originated as bud variations. It is reasonable to believe that additional varieties of commercial value may be secured in this way.

In the established varieties, no two stools, nor two stalks in the same stool, or even two eyes on the same stalk, are exactly alike. Variability is the rule in sugar cane rather than the exception. Some varieties are apparently more stable than others, while, in some instances, the frequent appearance of striking bud variations indicates that these varieties are in an active mutating stage.

In close planting, where the sugar cane plants are grown under conditions of severe competition, or where they are grown under poor cultural conditions, it seems apparent that the frequency and range of variability may not be so great as where the individual stools are grown under conditions of wider spacing and where the cultural conditions are most favorable to the individual plant development.

In some of the experimental bud selection progeny studies, it seems apparent that very interesting results may be secured through growing stools from single eyes, by spacing these stools at considerably wider distances in the row than is ordinarily the case in the regular field planting, and by giving these spaced single-eye plantings exceptionally good cultural conditions.

In practice, it seems probable that the three-eye seed pieces can be used to advantage in this experimental work by removing the two weakest or poorest eyes and leaving the best eye for the development of a stool, cutting the seed pieces, wherever possible, so that the best eye is the middle one. These seed pieces can be planted in the ordinary plant rows and spaced in the row one or more feet apart as circumstances warrant.

Some of the advantages of this method of experimental planting of some of the progenies in each variety include:

(1) The opportunity of studying the behaviour of individual stools which are known to be the development of the original growth from a single eye;

(2) The development of the variations in the progenies to the maximum degree and rate of occurrence;
(3) The physical advantage of being able to see the individual stools so that their characteristics can be more easily observed and the apparently desirable variations intelligently selected for further propagation.

It is probable that in every progeny field a small area devoted to spaced stools grown from single eyes is an important aid to bud selection work.

A. D. SHAMEL.

Liming at Pioneer Mill*

By Herbert Walker

Acting on the suggestion of Mr. W. R. McAllep of the Experiment Station we have increased the amount of lime used in clarification this year and seem so far to be getting better results. Formerly we limed the cold juice till just alkaline to litmus, trying to make the clarified juice about neutral. At the beginning of this season we gradually increased the lime till the cold juice was decidedly alkaline to litmus but still acid to phenolphthalein. We were planning to install a simple titration apparatus so as to maintain a slight definite acidity to phenol, but tests on a few tanks showed no trouble when the raw juice was slightly alkaline to phenol, and since the first few weeks all our juice has been so limed.

The phenol solution is made from 5 grams phenolphthalein dissolved in about 500 cc. denatured alcohol and made to 1000 cc. with water, then neutralized with dilute sodium hydroxide solution till a permanent pink color appears.

The man at the liming station fills a porcelain casserole with cold limed juice, pours it out again, and to the few drops remaining in the bottom of the casserole adds a drop of phenol solution. We try to lime so that the pink color to phenol is distinct but not excessive. This method of using phenol has proved more satisfactory than trying to observe the color in a test tube or on phenolphthalein paper.

Results. The increase in purity from mixed juice to syrup is 1.17 to date. Since 1913 our yearly average increase in purity has varied from a minimum of 0.25 to a maximum of 0.83. As a check we limed by our old method with litmus during the week ending April 1st. The following comparison shows the effect of so doing:

Week Ending	March 25	April 1	April 8
Lime % Cane	0.0586	0.0446	0.0628
Increase in purity	1.25	0.89	1.24
Limed with	phenol	litmus	phenol

According to laboratory tests made by Mr. McAllep March 24 and 25, the maximum possible increase in purity in mixed juice (obtained by liming to slight

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* Presented at the first annual meeting of the Association of Hawaiian Sugar Technologists, Honolulu, November 15-18, 1922.

phenol alkilinity and filtering through kieselguhr) was 1.34 in one test and 1.69 in another.

The gain in purity due to heavier liming is comparatively small, but its effect on the recovery is about equivalent to a reduction in purity of one point in the final molasses.

The undetermined losses to date are 0.58% sucrose in cane, which is considerably less than usual.

No trouble has occurred from excessive scale in the evaporator nor has there been any difficulty in boiling either commercial or low grade massecuites.

Disadvantages. Owing to the greater amount of precipitate removed from the juice, more settling tank capacity is required. We have had no trouble in getting a fairly clear juice, but have had some complaints from the mud press men on account of more juice going to that station along with the mud.

It seems to be a little more difficult to get a low purity final molasses. Actually on account of increased capacity we have managed to keep our waste molasses to date a point lower than last year, but to do this have to run off a molasses of about 96 Brix.

On the whole, we think the advantages of the extra lime outweigh the disadvantages, and we expect to continue this method through the year. If the undetermined losses continue to decrease, as they have so far, the gain in total recovery will more than offset any increased filter press and molasses losses.

Cane Varieties in Australia.

In The Australian Sugar Journal of November 3, 1922, H. T. Easterby, Director of the Sugar Experiment Bureau, writes:

> "The beneficial results of the work undertaken at the Experiment Station in the constant introduction and selection by cropping and chemical testing cannot be over-estimated. No cane has a perennial existence. Sooner or later, if constantly grown, it is bound to fall a victim to disease, and the Bureau must be on the constant lookout for new canes. That only a few canes of commercial value can be obtained from large numbers tested is, of course, well known. Out of many thousand seedlings raised in Queensland, only a few were finally selected. In Barbados over one million seedlings were raised, yet only four are in general use. At Demerara the same story obtains, there being only some seven canes that are of value out of considerably over a million raised. The farmer cannot undertake this work for himself, and must look to the Experiment Station for the introduction of new canes. A very great expenditure in time and money is thus saved to the grower. If no more had been done than the introduction of the two canes, Badila and Goru, into Queensland, it would have amply justified all the money that has so far been spent on sugar work."

[J. S. B.P., Jr.]

Potash in Cane Juices.

By Herbert Walker and George B. Glick

In a former article* the determination of plant food ingredients in cane juices was suggested as an aid in determining the fertilizer requirements of soils and the results of a number of analyses were given, showing a relationship between the phosphoric acid content of cane juices and that of the soil from which they were derived. We have lately extended this general idea to include the determination of potash as well. The customary method of weighing potash as the chlorplatinate requires more time and attention than can usually be afforded in a sugar factory laboratory. Sherill's centrifugal method, (Foot note—Sugar, Vol. 23, Nos. 5 and 6) modified for cane juices as follows, was found to be much more rapid and fairly accurate. The determination is based upon the relative volumes of precipitates formed from two solutions, the potash concentration of one of which is known.

REAGENTS AND APPARATUS

Standard 1% K_2O Sol.

Weigh carefully 15.83 gm. of C. P. Potassium Chloride, dissolve in distilled water in a liter volumetric flask, add 8 or 10 drops of glacial Acetic Acid and dilute to 1000 cc. with dist. water.

Sodium Cobaltic Nitrate Stock Sol.

To 225 gm. C. P. Sodium Nitrite (Na NO_2) add 400 cc. dist. water and allow to stand over night with occasional stirring. At the same time dissolve 125 gm. C. P. Cobalt Acetate in 400 cc. dist. water.

When the Sodium Nitrite is all dissolved pour the Cobalt Acetate into it and mix thoroughly by pouring repeatedly from one beaker to the other. Then dilute to 1000 cc. with dist. water.

This solution keeps very well for several months. A precipitate may form on long standing but has no harmful effect, as it entirely dissolves when the stock solution is diluted and acidified for use.

Sodium Cobaltic Nitrite Sol. for use.

To 100 cc. of stock sol. add 65 cc. dist. water and 5 cc. glacial Acetic Acid. Mix by shaking and allow to stand over night in a loosely stoppered bottle. Sodium Cobaltic Nitrite does not keep very well after it is acidified, so it is best to make up only enough for one day's supply at a time.

Centrifuge.

A Babcock milk-testing hand centrifuge with a four tube head and fitted with cork liners to take potash centrifuge tubes. Braun-Knecht-Heimann Cat. No. 4344 will answer the purpose well.

Potash Centrifuge Tubes.

These can be obtained from Braun-Knecht-Heimann. They should be calibrated before using. Using a 1 cc. pipette graduated to 1/100 cc. transfer 3/10 cc. of Mercury to one tube. By using the capillary tube for washing (described later) the mercury can be made to go down into the stem. The 3/10 cc. should fill the tube to the 15 mark.

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* Record Vol. XXVI, p. 317.

Transfer this mercury through a funnel from one tube to another. Record calibrations and compute factors where necessary.

Capillary Tube.

This is drawn from 1/8 inch glass tubing to about 4 inches in length. It should be connected to a large wash bottle and is used to wash the precipitates out of the tubes.

PROCEDURE

Determine the degree Brix of the juice and from this the sp. gr.

To about 500 cc. add milk of lime to faint Phenolphthalein alkalinity. Heat just to boiling and filter through a dry Buchner funnel, using suction. Pipette 150 cc. of the clarified juice, which must be bright and free from suspended and colloidal matter, into a 400 cc. beaker. Evaporate to less than 50 cc. on water bath or hot plate. Transfer to a 50 cc. volumetric flask, add 2.8 cc. of glacial acetic acid and make up to 50 cc. after cooling to room temperature, which should be above 72 F.

Transfer 17 cc. of the Sodium Cobaltic Nitrite sol. to each of two potash centrifuge tubes. Be sure that the stems are full of water and contain no air bubbles before adding the Nitrite sol.

To one tube add 5 cc. of the standard 1% K_2O sol. and to other 5 cc. of the prepared sample. Centrifuge at once for one minute at 1000 r.p.m. Allow the machine to come to a stop, remove each tube, level the precipitate by tapping the stems gently with the finger, replace in the machine, and centrifuge for 15 seconds more. Read and record results.

$$\% \; K_2O \;::\; \frac{50 \text{ X Reading of Sample.}}{150 \text{ X Sp. Gr. Juice X Reading of Standard.}}$$

Juices which are very low in K_2O and which do not give a reading sufficiently close to that of the standard to be reliable should be run again, using 10 cc. of the sample in one tube and 5 cc. of the standard K_2O sol. with 5 cc. of dist. water in the other. In this case, the formula gives twice the % K_2O in the juice.

The standard K_2O sol. does not give constant readings, due to temperature differences and the age of the Sodium Cobaltic Nitrite sol. Hence it is necessary to run a tube of the standard with every sample, or set of samples.

It is essential that the concentrated sample be bright and contain no precipitated or suspended matter after the acetic acid is added. If this is not the case, further clarification must be obtained by acidifying the filtrate from the lime clarification, heating and again filtering before taking the 150 cc. for analysis.

For comparative purposes the specific gravity of the juice may be neglected and results expressed as grams K_2O per 100 cc. juice.

We have started a complete phosphoric acid and potash survey of all our fields, based on analyses of crusher juice samples. Present indications are that none of our fields are in need of potash and that we shall probably be unable to derive a "safe minimum" figure from the juices of canes grown on this plantation. We have, however, found distinct and constant differences in the amount of K_2O in juices from different fields.

The effect of potash fertilization in increasing the K_2O content of cane juices is shown by the following tests of juices from Plant Food Experiment No. 4, Crop of 1923, a field experiment laid out to determine the increase in yield of sugar due to potash and phosphoric acid. The plots tested had received 200# nitrogen per acre, no phosphoric acid and either 0 or 200# potash. The cane

lacked several months of being ready to harvest. Three stalks were taken from each plot and run through a hand mill. The juices were analyzed as follows:

VARIETY—STRIPED MEXICAN

C Plots—No K_2O

Plot No.	% K_2O	% P_2O_5
128 C	.115	.012
138 C	.088	.010
148 C	.073	.008
136 C	.078	.017
132 C	.082	.017
142 C	.065	.015
152 C	.056	.010
Av.	.0796	.0127

J Plots—200 lbs. K_2O per acre

Plot No.	% K_2O	% P_2O_5
141 J	.088	.010
131 J	.167	.012
151 J	.181	.017
161 J	.158	.012
145 J	.173	.015
137 J	.083	.008
147 J	.114	.010
157 J	.187	.015
Av.	.144	.0124

Although there is considerable variation among the individual analyses which would be expected from the small samples used, the average juices from the K_2O plots are distinctly higher in this element. Since this field showed no decided gain from either potash or phosphoric acid when previously harvested in 1921, it seems probable that the canes from all plots have taken up a sufficient amount of these ingredients from the soil.

A similar test was made on canes from an experimental field in Olaa plantation. These soils have always given an increased yield from potash fertilization.

CANE FROM OLAA

Variety — Yellow Caledonia

Analysis of Juices from small hand mill — No K_2O

Sample No.	% K_2O	% P_2O_5
1	.028	
5	.027	
9	.057	.030
13	.048	
17	.050	.034
21	.049	.035
25	.021	.032
Av.	.040	.033

200 lbs. K_2O per acre

Sample No.	% K_2O	% P_2O_5
4	.074	
8	.076	
12	.104	.035
16	.137	.032
20	.119	
24	.099	.032
Av.	.101	.033

This series shows still more strongly the effect of fertilization on the amount of potash in the juices. The figures for P_2O_5 are given as an additional check on the effect which local variations in soil or cane might cause. Neither series showed any apparent influence of potash fertilization on the P_2O_5 content of the juice.

Reasoning from the two experiments the opinion might be hazarded that a cane juice containing less than 0.05% K_2O indicates the need of potash fertilization, and that one containing 0.10% K_2O probably does not. Whether these or any figures may be generally applicable or whether they may have to be modified for different cane varieties and localities will require a much more extended investigation to establish.

Effect of Nitrogen on Early Growth of Cane.

Sugar cane can use nitrogen applications to good advantage at a very early stage of growth.

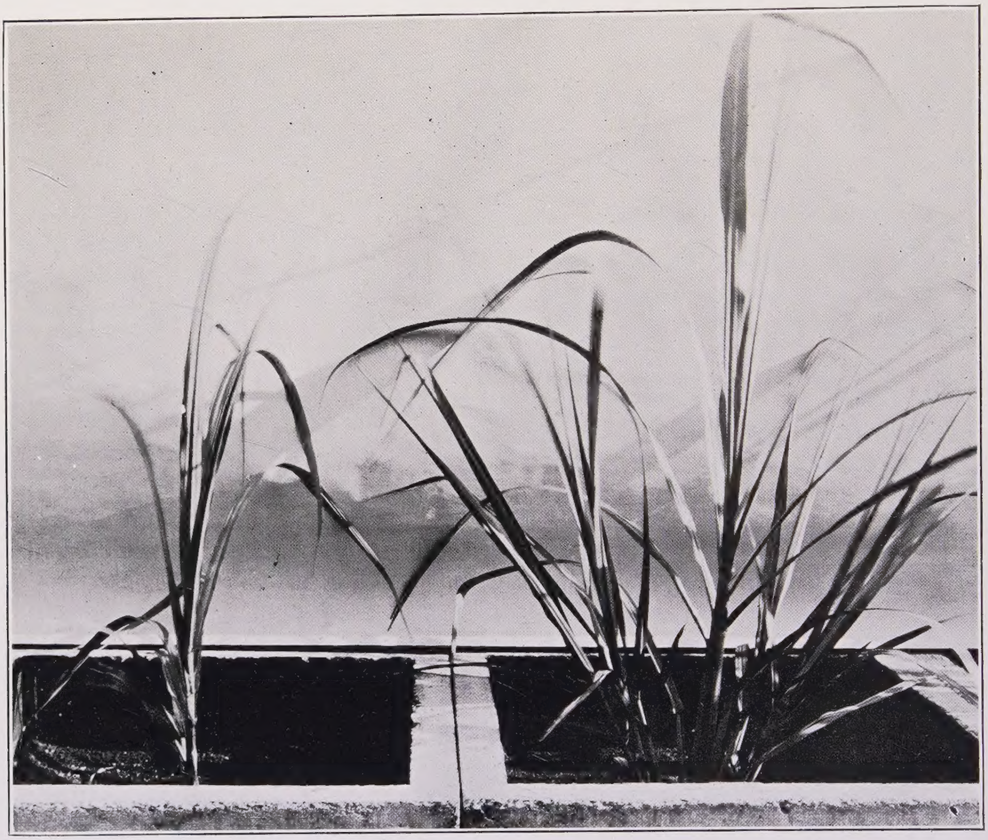
The difference in the two cane plants, here shown, is due to the fact that the one on the right received nitrate of soda when it was 37 days old (from date of planting). The picture was taken when the plants were 89 days old. The difference in growth came about, therefore, in 7½ weeks.

The results obtained here in concrete tubs are in keeping with field observations which are pointing with increasing emphasis to the value of early fertilization. It has customarily been the practice to allow a field to reach a good stand and attain a growth of 12 to 18 inches before applying fertilizer.

At the Waipio substation, acting on the recommendations of Mr. Paris, we are applying nitrate of soda at the rate of 50 pounds of nitrogen per acre to plant cane at a month from planting, to ratoons at two weeks or less from the time the field is cleared of the previous crop. This calls for the fertilization of ratoons either with or ahead of the first irrigation.

The results are pleasing. The cane gets a quick start, and closes in at an early date. To what extent, if any, the time of this first application should vary under different climatic conditions has not yet been investigated.

The two cane plants in the picture are being employed in a test to determine the limits to which one may go in applying nitrate of soda and sulphate of ammonia without bringing injury to the crop. Most experiments have dealt with the economic limit. From this test, which Mr. Stewart is conducting in



concrete tubs, we are to learn the point at which these nitrogen salts cease to be an aid to plant growth and become an actual detriment.

Nitrogen is being applied in different tubs each month at the rate of 0, 25, 50, 100 and 200 pounds of nitrogen per acre.

The cuttings (a single eye remaining on a three joint section) were planted in flats September 20, 1922. They were transferred to the tubs without disturbing the roots on October 11, 1922. The plant on the left had no fertilizer, the one on the right had nitrate of soda at the rate of 25 pounds per acre on October 27, 1922, and the dose was repeated November 27, 1922. The photograph was taken December 8, 1922. H. P. A.

The Effect of Phosphoric Acid and Potash on the Quality of Cane Juices.

By J. A. Verret

During recent years the average quality of cane juices on the different islands has shown a downward tendency. The question has been raised as to whether our systems of fertilizing were in any way responsible for this. With this in mind we have recently made a rather careful review of all our fertilizer experiments and compared the juices from the plots receiving different fertilizer treatments. In this paper we are reporting the results of this study in regard to the effect of phosphoric acid and potash.

The Action of Phosphorus and Potassium on Plants

Before going into the details of the results of our experiments here, we shall give briefly the effects produced on crops by these two elements as given in the literature. These general conclusions given by the different authors are based almost entirely upon temperate zone plants, mainly cereals.

Phosphoric acid is very beneficial in favoring the rapid development of young plants by stimulating the growth of roots. This points to the importance of the early application of phosphates.

Protoplasm cannot exist without phosphorus, and as there can be no plant growth without protoplasm this is very important.

Phosphates are reported to favor the early ripening of crops. The formation of grain is hastened by the free application of phosphates. This maturing effect of the phosphates is due to this hastening of seed formation. Phosphorus is always found more abundantly in the seed than in other parts of the plant. In non-seed crops this maturing effect may not be evident.

Potassium compounds are necessary in order that a plant may produce starch, sugar, cellulose and other carbohydrates. Potassium seems to be necessary for transference of starch from the leaves to other parts of the plant. Potash plays a large part in the development of leaves and the woody parts of the stems of plants. Larger portions of potash are found in these parts of plants. Large amounts of potash tend to prolong the life of plants, thereby delaying maturity, and thus having an effect directly opposite to that of phosphoric acid. Here we have an indication of the importance of early application of potash compounds in order that the potash needed may be used as early as possible and give time for the plant to mature. Potassium compounds give the plant more resistance to the attacks of fungous diseases, such as rusts, especially. Crops not receiving enough potash seem to be more susceptible to diseases of all kinds.

Experimental Results

The results herein reported are based on a total of 84 experiments, covering all the islands and extending from 1917 to 1922.

Each experiment consisted of from 5 to 12 repetitions of each treatment. In nearly all cases, all plots were sampled, and the juices averaged for each treatment. The figures given are the average of several hundrd juice analyses, composed of over a thousand samples, and it would therefore seem that the results obtained can be accepted as more or less conclusive.

The results show no effect whatever on the quality ratio of juices from the use or omission of either phosphoric acid or potash or both. This statement has no reference to the effect of phosphoric acid on the clarifying properties of a cane juice. Recent work by Walker of Pioneer Mill Company and McAllep of this Station points to the fact that the phosphoric acid content of a cane juice has a very important bearing in factory work. When below a certain minimum of phosphoric acid, juices clarify rather poorly. What that minimum is, or its relation to the phosphoric acid content of the soil, is not yet clearly established, as some obscure points remain to be worked out. For instance, the juice from certain fields may be rather low in P_2O_5 and not clarify very well, yet the cane fails to respond to phosphate applications.

Below we give in tabular form a summary of the results obtained from the different treatments:

PHOSPHORIC ACID

	Quality Ratio of Juice	
	Phos. Acid	No Phos. Acid
Average of all experiments responding to phosphates......	8.30	8.29
Average of all experiments not responding to phosphates..	8.46	8.40
Average of all	8.39	8.35

POTASH

	Quality of Juices	
	Potash	No Potash
Average of all experiments responding to potash applications	8.12	8.14
Average of all experiments not responding to potash application	8.24	8.17
Average of all	8.18	8.16

PHOSPHORIC ACID AND POTASH

	Quality of Juices	
	Phos. acid & Potash	No Phos. acid & Potash
Average of all experiments responding to phosphoric acid and potash	8.24	8.18
Average of all experiments not responding to phosphoric acid and potash	7.36	7.30
Average of all	7.92	7.86

The above results show that in arriving at the cause of our poorer juices we must look elsewhere than to the presence or absence of phosphoric acid or of potash in our fertilizers.

Some of these causes may be adverse climatic conditions, change of cane varieties, late harvesting, late fertilizing, increased nitrogen applications, increased yield of cane per acre, or age of cane when harvested.

Some of the above factors we can control, others we cannot. When Lahaina refuses to grow we must change to another variety of cane, even though the juices be poorer. We cannot do much with climate, but we can fertilize earlier.

With our present labor conditions, late harvesting is to be expected. Beginning in July, cane juices go back very fast. But this "going back" seems to apply to old cane in a much greater degree than it does to younger cane—that is cane 24 to 30 months old seems to deteriorate much more than is the case with cane 15 to 18 months old. Our best juices last year at Waipio were from short ratoons harvested in late August. We do not believe that these short ratoons had deteriorated at all when harvested.

We feel that this question of short ratooning is a very important field for more extensive experimentations on the plantations.

We would suggest the trial of short ratooning to the extent that all cane ground from July on, be short ratoons.

There is a possibility that the sugar made from this younger cane late in the year would have a better refining value than sugar made from older, deteriorated cane. Deterioration of cane is accompanied by more or less gum formation, and this, in turn, has a direct bearing on the filtering quality of the sugar.

In another paper we intend to take up the relation between nitrogenous fertilization and cane quality.

QUALITY OF JUICES IN PHOSPHORIC ACID EXPERIMENTS

	Quality Ratio of Juice		Gain from
Experiment	Phos. Acid	No Phos. Acid	Phos. Acid
Kilauea #5, 1917	9.50	9.38	No
Pepeekeo #1, 1917	7.08	7.02	No
Kilauea #7, 1918	8.58	8.54	No
O. S. Co. #6, 1918	9.50	9.53	Yes
O. S. Co. #6, 1920	7.02	7.02	Yes
O. S. Co. #6, 1922	8.24	8.66	Yes
Grove Farm #6, 1919	8.11	7.95	No
Hakalau #4, 1919	8.12	8.19	No
Hakalau #7, 1919	7.58	7.67	No
Honomu #1, 1919	8.73	8.57	No
Paauhau #12, 1919	8.02	8.01	Slight
Paauhau #12, 1921	9.43	9.48	Yes
Kilauea #27, 1921	9.40	9.20	Yes
Kilauea #17, 1920	9.71	9.62	No
Kilauea #17, 1922	11.40	11.12	No
Kilauea #34, 1921	8.68	9.04	Yes
Kilauea #35, 1921	8.87	8.92	Yes
Lihue #1, 1921	8.91	8.71	No
Lihue #2, 1921	8.80	8.92	No
M. A. Co. #8, 1921	8.99	8.71	No
Pioneer #3, 1921	7.27	7.18	No
Pioneer #4, 1921	6.71	6.71	Slight
Waipio V, 1917	8.94	8.89	No
Waipio V, 1918	9.29	9.46	No
Waipio V, 1919	8.53	8.54	No
Waipio V, 1921	9.15	9.15	No
McBryde #2, 1919	7.48	7.42	No

Experiment	Quality Ratio of Juice — Phos. Acid	Quality Ratio of Juice — No Phos. Acid	Gain from Phos. Acid
McBryde #2, 1921	7.51	7.23	No
Onomea #9, 1919	7.55	7.81	No
Onomea #9, 1921	7.40	7.19	No
O. S. Co. #4, 1922	8.95	8.72	Yes
O. S. Co. #14, 1920	7.11	7.11	Yes
H. C. & S. Co. #7, 1921	6.76	6.79	Yes
H. M. Co. #5, 1922	7.58	7.47	No
H. M. Co. #3, 1922	7.24	7.27	Yes
G. F. #9, 1922	7.92	8.33	Yes
H. A. Co. #2, 1922	8.26	8.29	Yes
Kilauea #29, 1922	11.43	10.79	Yes
Kilauea #30, 1922	8.19	7.76	Yes
Lihue #6, 1922	8.40	8.00	Yes
Lihue #7, 1922	7.70	7.80	Yes
Averages	8.39	8.35	
Averages of experiments which responded	8.30	8.29	
Averages of experiments which did not respond	8.46	8.40	

QUALITY OF JUICES IN POTASH EXPERIMENTS

Experiment	Quality Ratio of Juice — Potash	Quality Ratio of Juice — No Potash	Gain from Potash
Onomea #6, 1918	8.42	8.27	Yes
Onomea #6, 1920	8.64	8.58	Yes
Onomea #6, 1922	7.95	7.77	Yes
Onomea #8, 1919	7.61	8.11	Yes
Onomea #8, 1921	8.67	8.56	Yes
Kilauea #23, 1920	9.58	9.94	Yes
Kilauea #24, 1920	9.73	9.73	Slight
Honokaa Obs. B, 1921	7.40	7.65	Yes
Kilauea #25, 1921	8.30	8.29	Slight
Pioneer #4, 1921	6.70	6.73	Slight
Hamakua #5, 1922	7.74	7.30	No
Kilauea #31, 1922	9.58	9.55	No
Oahu S. Co. #8, 1922	8.60	8.64	No
Pepeekeo #6, 1922	8.05	7.88	Yes
Onomea #11, 1922	7.71	7.25	Yes
Waipio V, 1917	9.00	9.11	No
Waipio V, 1918	9.37	9.12	No
Waipio V, 1919	8.68	8.29	No
Waipio V, 1921	9.13	9.13	No
McBryde #2, 1919	7.53	7.43	No
McBryde #2, 1921	7.24	7.46	No
Onomea #9, 1919	7.62	7.91	Yes
Onomea #9, 1921	7.32	7.27	Yes
Oahu S. Co. #4, 1920	7.41	7.46	No
Oahu S. Co. #14, 1920	7.13	6.89	No
H. C. & S. #7, 1921	6.78	6.80	No
Lihue #2, 1921	8.81	8.78	No
M. A. Co. #8, 1921	8.85	8.90	No
Lihue #7, 1922	7.65	7.76	No
Averages	8.18	8.16	

Experiment	Quality Ratio of Juice: Potash	Quality Ratio of Juice: No Potash	Gain from Potash
Averages of all experiments responding to potash	8.12	8.14	
Averages of all experiments not responding to potash	8.24	8.17	

QUALITY OF JUICES IN PLANT FOOD EXPERIMENTS

Experiment	Nitrogen, Phos. Acid and Potash	Nitrogen only	Gain from Phos. Acid and Potash
Waipio V, 1917	9.59	9.53	No
Waipio V, 1918	9.41	9.54	No
Waipio V, 1919	8.06	7.90	No
Waipio V, 1921	9.15	9.15	No
McBryde #2, 1919	7.53	7.42	No
Onomea #9, 1919	7.77	8.14	Yes
Onomea #9, 1921	7.34	7.08	Yes
O. S. Co. #4,1920	7.88	7.56	Yes
O. S. Co. #14, 1920	7.11	7.00	Yes
H. C. & S. Co. #7, 1921	6.76	6.80	No
Lihue #2, 1921	8.92	8.78	No
Maui Agri. Co. #8, 1921	8.71	8.98	No
Pioneer #4, 1921	6.71	6.73	Yes
H. M. Co. #5, 1922	7.78	7.23	No
Lihue #7, 1922	7.80	7.80	No
Averages	7.92	7.86	
Averages of experiments which responded	8.24	8.18	
Averages of experiments which did not respond	7.36	7.30	

CANE FIELDS AT HIGH ALTITUDE.

This photograph was sent by Dr. F. X. Williams from Ecuador. It shows the village of Baños surrounded by cane fields at 6,000 feet elevation. In the background is seen the active volcano Tunguragua rising to a height of 17,000 feet.

Quality of Cane.

By W. R. McAllep

During the preparation of the last annual synopsis, figures for quality of cane that had been reported for previous synopses were compiled. From these data quality ratios of the cane for each island and for the whole group were calculated for the years 1908 to 1922 inclusive. This is arranged in graphic form in figure 1. In calculating these quality ratios the actual polarization of the

cane was used instead of 80% of the polarization of the first extracted juice; the figure usually assumed as the polarization of the cane in the ordinary calculation.

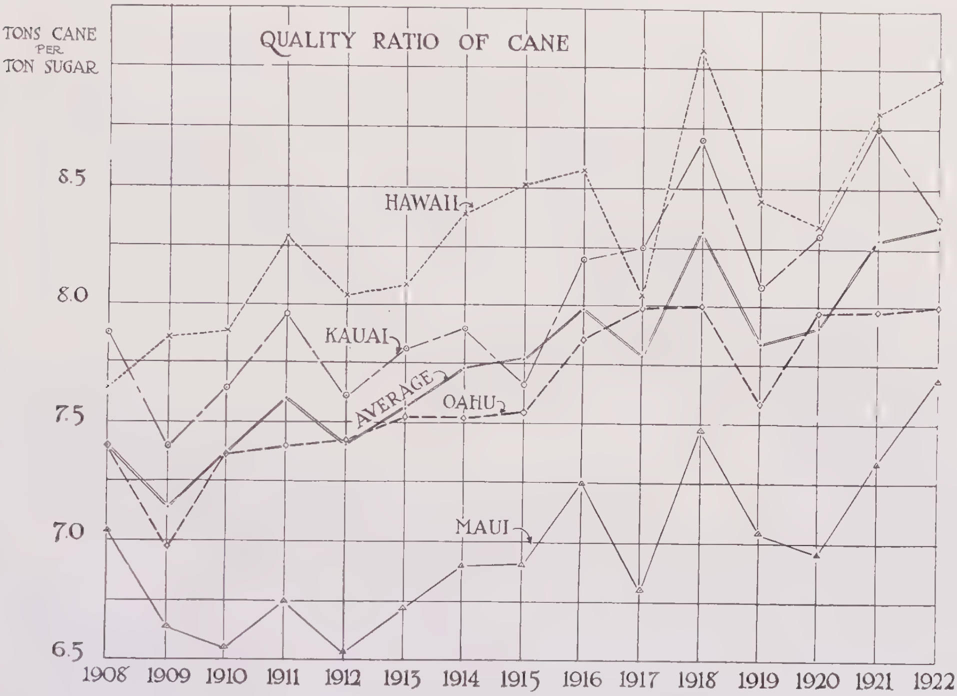


Fig. 1.

The extent that the quality of the cane has been going back from year to year is shown quite clearly by this graph. The following comments apply more particularly to the general slope of the curves than to the seasonal variations in quality for single years. The curve representing the average quality ratio for the whole group indicates that the best quality ratio was in 1909 and the poorest in 1922. Between these years the change is fairly consistent, amounting altogether to an increase of 1.2 tons of cane per ton of sugar. The line representing the Island of Hawaii shows a fairly consistent increase in quality ratio during the whole of the 15 year period. On Kauai during the first half of the period, no definite change in quality is indicated. Subsequent to 1915, however, the quality ratio materially increased. It is rather difficult to decide how much this increase amounts to and what the present tendency is because of irregularity in the last few years, due to large seasonal variations. On Oahu the quality was much better in the year 1909 than in other seasons. With the exception of this one season, from 1908 to 1915 there is a gradual but very small increase in quality ratio amounting altogether for the seven years to about one-tenth of a ton of cane per ton of sugar. During the next two years it increased approximately half a ton. Since that time, however, there has been no further increase. On Maui the quality improved during the first five years of this period. Since that time there has been a large increase in the quality ratio.

Maui has throughout the period been first in quality of cane, then Oahu, usually somewhat better than the average, next Kauai and last Hawaii. This has been the order with but two exceptions throughout the entire fifteen year period. The exceptions were that in 1908 and 1917 the cane on Kauai was of poorer quality than that on Hawaii.

The cane on Maui, Kauai and Hawaii shows a marked tendency to follow similar seasonal variations. These seasonal variations are much less pronounced on Oahu and in but a few instances only does the curve for this island indicate the same seasonal variations shown by the curves for the others.

Possibly the most interesting feature shown by figure 1 is that on Oahu, deterioration in the quality of the cane has apparently been checked, the curve for the last six years showing little if any tendency towards a decrease in quality of cane.

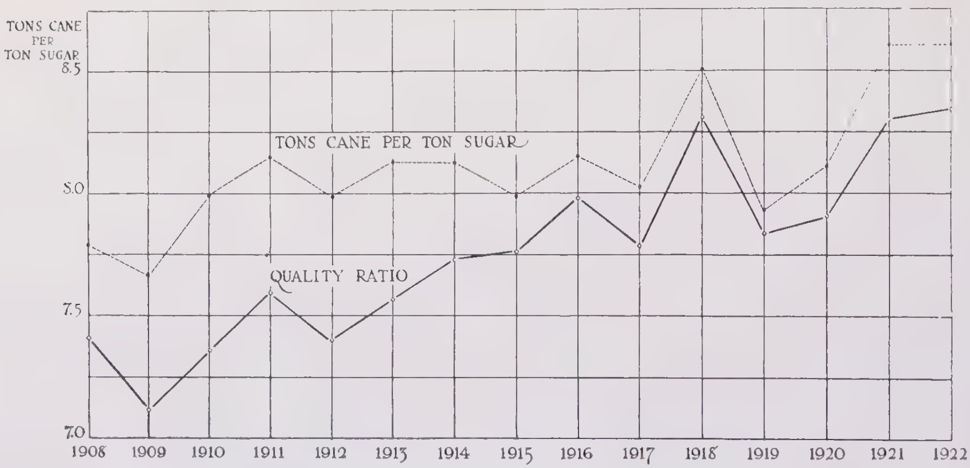


Fig. 2.

A second graph, figure 2, also prepared while studying data submitted for the Annual Synopsis, may be of interest. This is a comparison of the quality ratio with the tons of cane actually required to make a ton of sugar. It brings out the rather interesting point, that during the decade between 1910 and 1920, though the cane was constantly becoming poorer in quality, the amount of cane required to produce a ton of sugar remained practically constant, higher recoveries due to better factory work approximately offsetting the decrease in the quality of the cane. The lines converge fairly steadily up to 1919 and then diverge, indicating that the high point in factory work was reached in 1919. The decrease in the quality of the factory work since that time, however, has been slightly less than the diverging lines in the figure indicate, as it has been somewhat influenced by an increase in the polarization of the sugar. In 1921 and 1922 the polarization of the sugar was approximately 0.5 higher than in 1919. Had the sugar polarization been the same as in 1919 the distance between the two lines would be reduced by about one-fifth.

A Long Distance Shipment of Seed Cane.

Acting upon a request from the Oahu Sugar Company, on April 8, 1922, we cut and shipped to J. C. Arenberg Peeters, Koedoes, Java, twelve cuttings of seed cane of H 109. This shipment, which went forward by mail, met with undue delay at Hongkong, owing to shipping strikes, and reached Mr. Peeters on September 10, 1922. In a letter received from Mr. Peeters, he states:

> " . . . I feared the cane would be already dead, it being on the road for five months, but, to my great joy, ten from twelve cuttings proved to be still alive."

Mr. Peeters attributes the success of this shipment to the manner of packing, which was handled by Y. Kutsunai and is described as follows:

H 109 SHIPPED TO JAVA ON APRIL 8, 1922.

(1) *Seeds.* H 109 seeds were cut in Makiki field 9C, from 16 month cane. Top 6 inches were cut away and the next 2 feet were taken as seed. Healthy stick only was used as the source of seed. Each seed was inspected. Good seeds only were used. They were washed, wiped dry, and cut squarely to 15 inch length with seed cane cutter. The cut ends were paraffined immediately and labeled.

(2) *Packing Tube.* Galvanized iron tube 4 inches square and 16 inches deep with a lid overlapping 3 inches, made of 26 gage Armco iron. The tube was previously washed in water to remove acids, and dried.

(3) *Moist Charcoal Powder.* Algaroba charcoal powder passed 1/4 inch mesh was moistened with clean water at the rate of 10 pounds charcoal with 2 pounds of water.

(4) *Packing.* The tube was set upright without the lid. A handful of moist charcoal was thrown in. Four seeds were then set upright in the tube in such a way that each seed did not come in contact with other seed or the sides of the tube. All open room was filled with the moist charcoal powder as tightly as possible by jarring the tube. When the tube was entirely full, it was covered, labeled, wrapped with Manila paper, and shipped.

(5) *Gross and Net Weights.* Tube only weighed 2 lbs. 9 oz.; tube with moist charcoal, 9 lbs. 2 oz.; moist charcoal only, 6 lbs. 9 oz.

H. P. A.

Phosphoric Acid and Potash at Wailuku.

WAILUKU SUGAR COMPANY—EXPERIMENT 11 (1923 CROP)

This test was in field 37, Wailuku Sugar Co. This is one of the highest fields on the plantation, being at about 675 feet elevation. The cane was H 146, first ratoons. The stand of cane was very uneven from the beginning. This detracts somewhat from the value of the results.

All plots received nitrogen at the rate of 172 pounds per acre from 1110 pounds of nitrate of soda. In addition to this, four plots (A plots) received 375 pounds of acid phosphate per acre, equal to 60 pounds of P_2O_5. In addition to

nitrogen the four B plots were given 62.5 pounds of potash per acre from 125 pounds of sulphate of potash.

The four C plots were given both phosphoric acid and potash at the rates mentioned above.

The fertilizer was applied in two doses, in October, 1921, and March, 1922. Half the nitrogen, and all the phosphoric acid and potash were applied in October.

The experiment was harvested by the plantation. The two middle lines of each plot were weighed on field scales. The tons per acre are based on 250 lines per acre. The crusher juice samples are from carload lots.

The treatments given the different plots are tabulated as follows:

FERTILIZATION—LBS. PER ACRE

Plots	October, 1921	March, 1922	N.	P_2O_5	K_2O
X	555# N. S.	555# N. S.	172	0	0
A	555# N. S. 375# A. P.	555# N. S. 0	172	60	0
B	555# N. S. 125# S. P.	555# N. S. 0	172	0	62.5
C	555# N. S. 375# A. P. 125# S. P.	555# N. S. 0 0	172	60	62.5

Nitrate of Soda=15.5% N.
Acid Phosphate=16% P_2O_5.
Sulphate Potash=50% K_2O.

The yields were as follows:

SUMMARY OF TREATMENT AND YIELDS.

	Yield per Acre		
Treatment	Cane	Q. R.	Sugar
Nitrogen and phos. acid	30.8	8.05	3.83
Adjoining plots nitrogen alone	31.2	8.04	3.88
Nitrogen and potash	34.8	7.93	4.39
Adjoining plots nitrogen alone	36.6	8.04	4.55
Nitrogen, phosphate acid and potash	38.6	8.18	4.72
Adjoining plots nitrogen alone	37.5	8.04	4.67
Average all plots getting phos. acid or/and potash	34.7	8.05	4.31
Average all plots getting nitrogen only	36.0	8.04	4.48

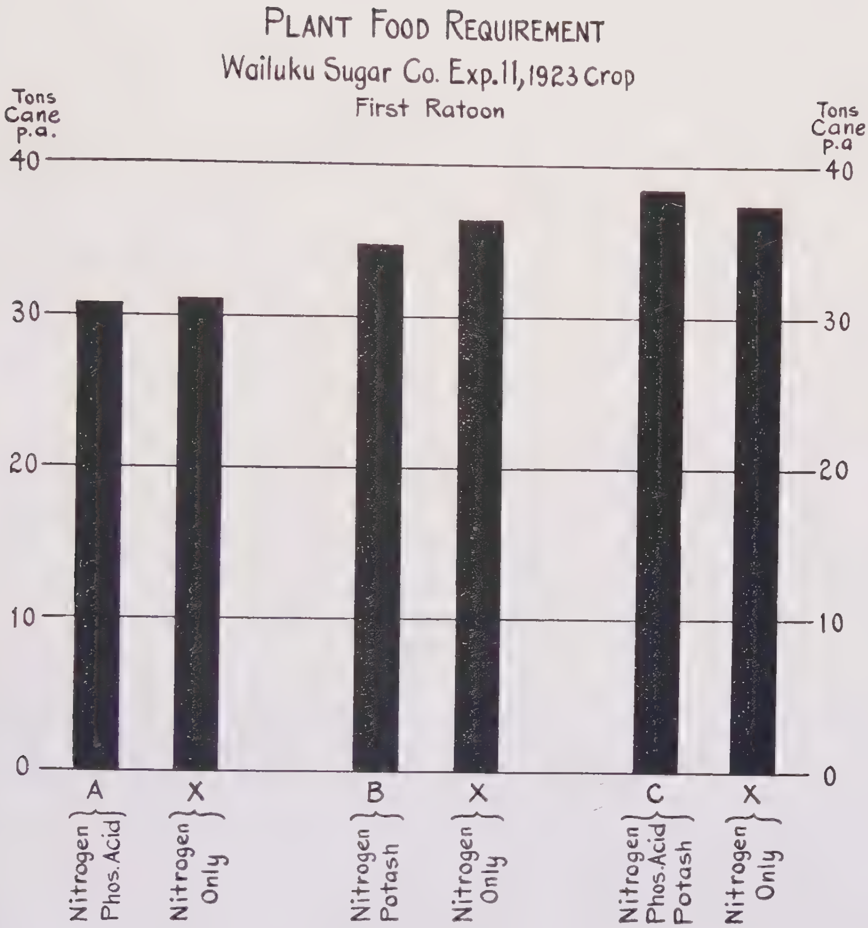
The results show no gain from either the phosphoric acid or the potash. These results should be followed up with more experiments and soil analyses. We have but few soil samples from Wailuku and some of these are rather low in phosphoric acid.

DETAILS OF EXPERIMENT

Fertilization Test

Object:

To compare nitrogen alone, with nitrogen and phos. acid, nitrogen and potash, and nitrogen, phos. acid and potash.



Summary Of Results

Plots	Treatment	Yield Per Acre		
		Cane	Q.R.	Sugar
A	Nitrogen And Phosphoric Acid.	30.8	8.05	3.83
X	Adjoining Plots Nitrogen Alone.	31.2	8.04	3 88
B	Nitrogen And Sulphate Of Potash.	34.8	7.93	4.39
X	Adjoining Plots Nitrogen Alone.	36.6	8.04	4.55
C	Nitrogen, Phos. Acid And Potash.	38.6	8.18	4.72
X	Adjoining Plots Nitrogen Alone.	37 5	8.04	4.67

Location:

Wailuku Sugar Co., Field #37, elevation 650 to 700 feet.

Crop:

H 146, 1st ratoons.

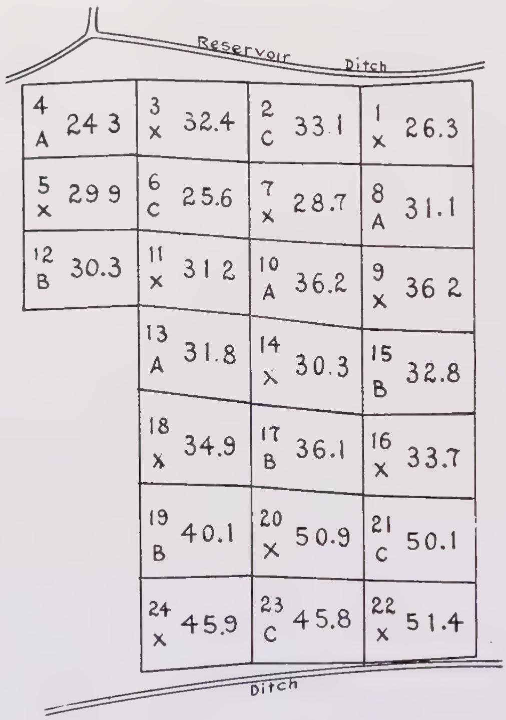
Layout:

28 plots of varying areas (approximately .025 acre). Each plot one watercourse wide.

PLANT FOOD REQUIREMENT

Wailuku Sugar Co. Exp. 11, 1923 Crop

Field 37



Plan:

Fertilizer—Pounds per Acre.

Plots	October, 1921	March, 1922
X	555# Nitrate of Soda	555# Nitrate of Soda
A	555# Nitrate of Soda 375# Acid Phosphate	555# Nitrate of Soda O
B	555# Nitrate of Soda 125# Sulphate of Potash	555# Nitrate of Soda O
C	555# Nitrate of Soda 375# Acid Phosphate 125# Sulphate of Potash	555# Nitrate of Soda O O

Field harvested by plantation January, 1923.
Juices sampled in carload lots at mill.

J. A. V.

Field Experiments at Pioneer Mill Company, 1921 and 1923 Crops.

Exp. 1—Variety Test.
Exp. 2—Amount of Fertilizer to Apply.
Exp. 3—Phosphoric Acid Test.
Exp. 4—Phosphoric Acid and Potash.
Exp. 5—Number of Applications of Fertilizer.

By J. A. Verret

These experiments are in field B 6, Kaanapali Section, Pioneer Mill Co., and are at an elevation of about 400 feet. They have now been carried on through two crops, one plant and one ratoon. Except in Experiment #1, which is a variety test, the cane is Striped Mexican. The first crop was two years old at harvest, the second eighteen months. The first crop suffered to some extent for lack of water, especially during its second year of growth.

In comparing D 1135, Striped Mexican, H 109, H 33, Lahaina and H 146, the D 1135 led in both crops by a large margin in cane and sugar. Striped Mexican was next, with H 109 third.

The profitable limit in fertilization was found to lie between 150 to 200 pounds of nitrogen per acre, depending on conditions.

Phosphoric acid was found to give increased yields. The returns from potash are somewhat doubtful. Further tests are being conducted to determine this point. Applying the fertilizer in 2, 3 or 4 doses made no essential differences in the yield of cane.

EXPERIMENT No. 1—VARIETY TEST.

In this test D 1135, Striped Mexican, H 109, H 33, Lahaina and H 146 were compared. Two crops have now been harvested. The first crop, plant, was 24½ months old when harvested in August, 1921, the second was 17½ months old at harvest in February, 1923.

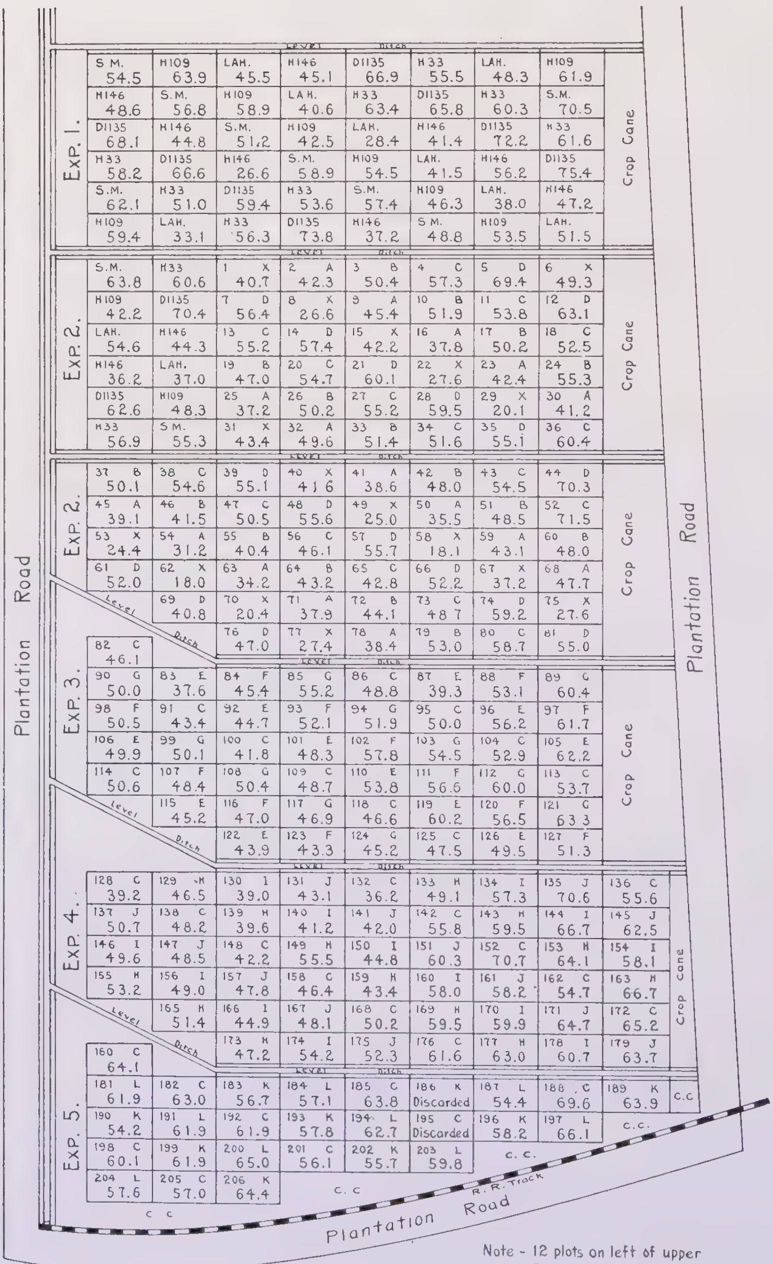
The results obtained from the two crops were as follows:

	Tons Cane per Acre		Tons Sugar per Acre		Total Sugar per acre in
Variety	1921	1923	1921	1923	two crops
D 1135	51.5	68.1	7.44	8.98	16.42
Str. Mex.	44.2	57.9	6.16	7.75	13.91
H 109	44.6	53.1	6.60	6.91	13.51
H 33	43.3	57.7	5.64	7.42	13.06
Lahaina	41.4	41.8	6.17	5.39	11.56
H 146	30.2	42.7	4.03	5.69	9.72

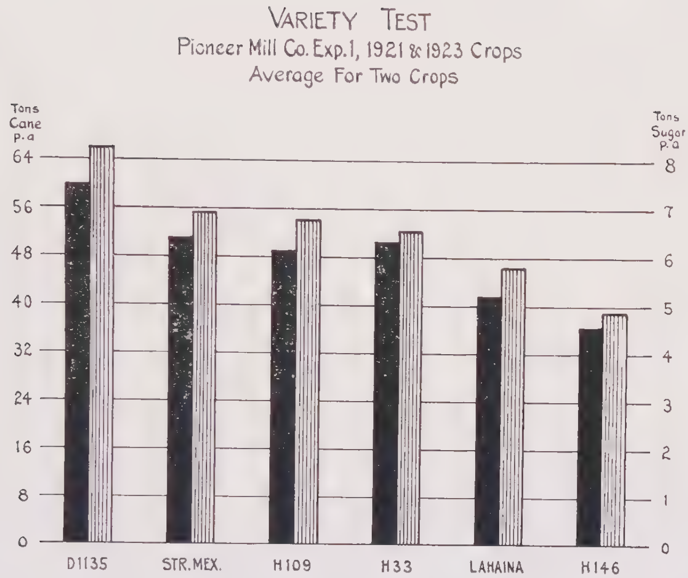
We note from the above results that the D 1135 was distinctly superior to any other variety. Not only were the cane yields heavier, but in both crops the juices were as good or better than the juices of any of the other varieties, including Lahaina.

Exp. 1. Variety Test.
Exp. 2. Amount Of Nitrogen To Apply.
Exp. 3. Phosphoric Acid Requirements.
Exp. 4. Plant Food Requirements.
Exp. 5. Number Of Applications.

Pioneer Mill Co. Expts. 1, 2, 3, 4 & 5, 1923 Crop
Field B6-L.



Note - 12 plots on left of upper Exp. 2. = Exp 1. Others = Exp 2.



The Lahaina and H 146 made a very poor showing and should not be planted in fields similar to one in which this test was conducted. The results obtained from H 146 are poorer than indicated by the yields. It was necessary to replant the H 146 plots rather heavily with Striped Mexican.

On the other hand, we believe D 1135 should receive more attention than it does. We hear a great deal about the difficulties in harvesting this cane, and not enough about its value as a fast ratooner, making weed control comparatively easy compared to other varieties. We do not believe that the man-days per ton of cane delivered at the mill is greater with D 1135 than with some of the other standard varieties. We know of a number of cases where it was less.

Details of Experiment.

VARIETY TEST.

Object:

To compare H 33, H 109, H 146, D 1135, Striped Mexican and Lahaina.

Location:

Pioneer Mill Co., Field B 6, Kaanapali Section.

Layout:

Number of plots, 60.

Size of plots, 1/20 acre, consisting of 7 rows two watercourses long; by measurement 31.5′ x 69.15′ from center to center of watercourse. Each row, 4.5′ x 69.15′.

Crop:

H 33, H 109, H 146, D 1135, Striped Mexican and Lahaina; 1st ratoons.

Previous crop harvested August, 1921.

Plan:

FERTILIZATION

One dose of high grade and one dose of nitrate of soda, amounting to 200 lbs. of N. and 60 lbs. of P_2O_5 per acre uniform or regular plantation practice.

Experiment harvested in Feb., 1923, by J. S. B. Pratt, Jr., helped by the plantation. The cane was sampled in carload lots at the mill by the plantation.

EXPERIMENT No. 2—AMOUNT OF FERTILIZER

In this test varying amounts of nitrogen were compared, ranging from 0 to 250 pounds of nitrogen per acre. Half of the nitrogen was applied the first year and was from complete fertilizer composed of 10% nitrogen, 7% P_2O_5 and 3.75% potash. Second season fertilization was from nitrate of soda.

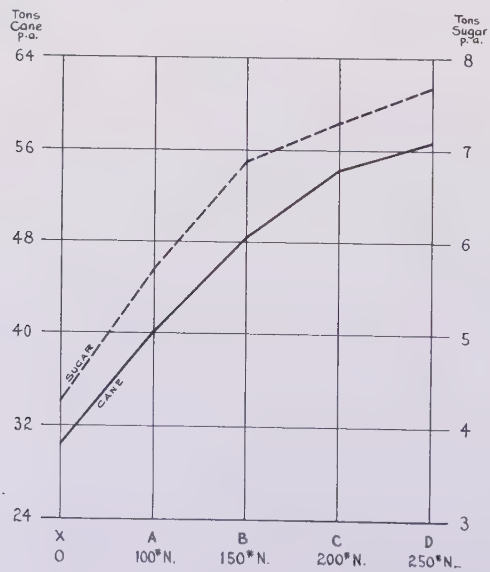
The plant cane received its fertilizer in four doses, two the first year and two the second year. The last crop got fertilizer in two doses only, one the first and one the second year. The fertilizations are tabulated as follows:

	POUNDS PER ACRE						Total
	1921 Crop				1923 Crop		Pounds
	High Grade		Nitrate Soda		High Grade	Nit. Soda	of
Plots	Oct. 1919	Nov. 1919	Feb. 1920	May 1920	Oct. 1921	Apr. 1922	Nitrogen
X	0	0	0	0	0	0	0
A	250	250	161	161	500	323	100
B	375	375	242	242	750	484	150
C	500	500	323	323	1000	645	200
D	625	625	403	403	1250	806	250

The results obtained from the two crops are tabulated as follows:

Pounds of Nitrogen	Cane per Acre		Sugar per Acre		Total Sugar per
per Acre	1921 Crop	1923 Crop	1921 Crop	1923 Crop	Acre for two crops
0	42.2	30.6	6.50	4.29	10.79
100	43.5	40.1	6.58	5.71	12.29
150	48.4	48.3	7.39	6.88	14.27
200	49.2	54.2	7.22	7.30	14.52
250	49.4	56.7	7.30	7.65	14.95

AMOUNT OF NITROGEN TO APPLY
Pioneer Mill Co. Exp. 2, 1923 Crop
Field B6-L.



In this experiment we find the response to fertilization to be much greater in the ratoons than in the plant crop. This was to some extent due to water shortage in the plant crop. The economic limit in fertilization in this case is found to be from 150 to over 200 pounds of nitrogen per acre, depending upon conditions. In fields with good, deep soils, a good stand of cane, and enough water, it would seem that 200 to 250 pounds of nitrogen per acre could be used to advantage. On the other hand, if the stand of cane is poor, if the field is difficult to irrigate or the water short, 150 pounds may be the limit.

Details of Experiment.

Fertilization—Amount to Apply

Object:

To determine the economic limit of nitrogen as a fertilizer on the lands of Pioneer Mill Co. that have been cropped for many years.

Location:

Pioneer Mill Co., Field B 6.

Crop:

Striped Mexican, 1st ratoon.
Previous crop harvested August, 1921.

Layout:

No. of plots, 81.
Size of plots, 1/20 acre; each plot is 7 lines by 2 watercourses, each line being 4.5′ wide by 69.15′ long.

Plan:

Plots	No. of Plots	Pounds Fertilizer per Acre: Oct. 1921 Mixed Fert.	Pounds Fertilizer per Acre: Apr. 1922 Nit. of Soda	Total Nitrogen
X	16	0	0	0
A	16	500	323	100
B	16	750	484	150
C	16	1000	645	200
D	17	1250	806	250

Mixed Fertilizer 1st. season..10% $\left\{\begin{array}{ll}3\frac{1}{2} & \text{N. S.}\\ 5 & \text{S. A.}\\ 1\frac{1}{2} & \text{Org.}\end{array}\right.$
7% P_2O_5 Super
3.75% K_2O
Nitrate of Soda, 2nd. season..15.5% N.

Experiment harvested in Feb. 1923, by J. S. B. Pratt, Jr., with the help of the plantation.

Cane sampled in carload lots at the mill by the plantation.

EXPERIMENT No. 3—PHOSPHORIC ACID.

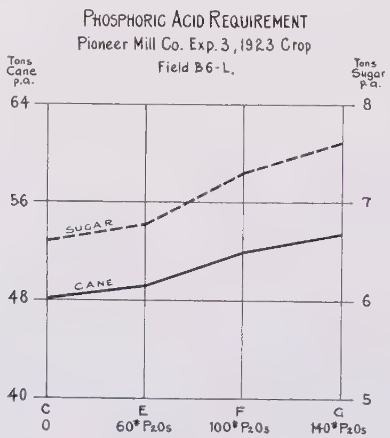
This experiment compared varying amounts of phosphoric acid, ranging from 0 to 140 pounds per acre of P_2O_5. All plots received a uniform application of nitrogen at the rate of 200 pounds per acre from nitrate of soda. The phosphoric acid was applied in one dose in October, 1921. The nitrogen was applied in two doses, October, 1921, and April, 1922.

The phosphate treatments and the yields obtained are tabulated as follows:

Treatment	Tons Cane per acre 1921 Crop	Tons Cane per acre 1923 Crop	Tons Sugar per acre 1921 Crop	Tons Sugar per acre 1923 Crop	Total Cane per acre for two crops
No Phosphate	44.8	48.2	6.24	6.61	93.0
375 Lbs. Acid Phosphate	44.4	49.2	6.04	6.76	93.6
625 " " "	45.3	52.0	6.26	7.29	97.3
875 " " "	46.3	53.4	6.41	7.61	99.7

The results from this experiment show a consistent gain of cane and sugar for increasing amounts of P_2O_5 from 60 pounds to 140 pounds per acre. This gain amounts to about 0.25 ton of sugar per acre for each increase.

We are somewhat at a loss to explain why there is no gain in sugar shown between the plots getting no phosphate and those receiving 60 pounds P_2O_5 per acre, but we believe this to be due to some unavoidable experimental discrepancy. In the plant crop, for instance, the juice from the A plots (60 lbs. P_2O_5) were poorer than the juices from the other series of plots. There is no reason why this should be so. An average of all our phosphate tests shows that phosphoric acid has no effect on the quality ratio of cane juices. In the ratoon crop two plots from this series gave much lower yields than the other plots. The same thing occurred in the plant crop, only to a lesser degree.



If a correction be made for the juices in the plant crop, and these two poor plots be omitted from the ratoon crop, the results appear much more consistent, as shown below:

Treatment	Tons Sugar per Acre 1921 Crop	Tons Sugar per Acre 1923 Crop	Total Sugar per acre for 2 Crops
No Phosphate	6.24	6.61	12.85
60 Lbs. P_2O_5	6.14	7.08	13.22
100 " "	6.26	7.29	13.55
140 " "	6.41	7.61	14.02

We believe the figures given in the last table to more nearly represent the actual conditions of the experiment.

Details of Experiment.

PHOSPHORIC ACID TEST

Object:

To determine the profitable limit in the application of phosphoric acid.

Location:

Pioneer Mill Co., Field B 6, Kaanapali Section.

Crop:

Striped Mexican, 1st ratoons.

Previous crop harvested August, 1921.

Layout:

46 plots, each 1/20 acre, 7 lines, 2 watercourses long. Each line 4.5′ by 69.15′ from center to center of watercourse.

Plan:

Plots	No. of Plots	Fertilization—Pounds per Acre: Nitrate Soda October, 1921	Acid Phosphate October, 1921	Nitrate Soda April, 1922	Total N.	Pounds P_2O_5
C	11	645	0	645	200	0
E	12	645	375	645	200	60
F	12	645	625	645	200	100
G	11	645	875	645	200	140

P_2O_5 from super phosphate—16% P_2O_5.

Nitrogen from nitrate of soda—15.5% N.

Experiment harvested by J. S. B. Pratt, Jr., in February, 1923, with the help of the plantation.

Cane sampled in carload lots at the mill by the plantation.

EXPERIMENT No. 4—PHOSPHORIC ACID AND POTASH

This was a test to determine the value of potash and of phosphoric and potash. All plots received nitrogen at the rate of 200 pounds per acre from nitrate of soda. The phosphoric acid and potash was applied in one dose in October, 1921. The nitrogen was applied in two doses in October, 1921, and April, 1922.

The results obtained from the two crops are as follows:

Treatment	Cane per Acre		Sugar per Acre		Total Tons Cane per Acre for two Crops
	1921 Crop	1923 Crop	1921 Crop	1923 Crop	
Nitrogen only	48.4	52.2	7.19	6.97	100.6
Nitrogen and Potash..... (100# K_2O)	48.9	52.6	7.31	7.31	101.5
Nitrogen and Potash..... (200# K_2O)	49.4	54.8	7.36	7.81	104.2
Nitrogen, Phos. Acid and Potash	50.8	53.7	7.57	7.53	104.5

In this test both the phosphoric acid and potash show some gains, but the gains in cane tonnage are comparatively small, so we cannot regard these results as conclusive until further work has been done.

Details of Experiment.

FERTILIZATION—PHOSPHORIC ACID AND POTASH

Object:

To determine the plant food requirements of sugar cane under conditions at Pioneer Mill Co.

Location:

Pioneer Mill Co., Field B 6.

Crop:

Striped Mexican, 1st ratoons.

Previous crop harvested August, 1921.

Layout:

No. of plots, 52.

Size of plots, 1/20 acre; each plot is 7 lines by 2 watercourses, each line being 4.5′ wide by 69.15′ long.

Plan:

Plots	No. of Plots	October, 1921 N.	October, 1921 P_2O_5	October, 1921 K_2O	April, 1922	Total lbs. per acre N.	Total lbs. per acre P_2O_5	Total lbs. per acre K_2O
C	13	100	0	0	100	200	0	0
H	13	100	100	100	100	200	100	100
I	13	100	0	100	100	200	0	100
J	13	100	0	200	100	200	0	200

N—from nitrate of soda—15.5% N.

P_2O_5—acid phosphate—16%.

K_2O—sulp. potash—50%.

Experiment harvested by J. S. B. Pratt, Jr., in February, 1923, with the help of the plantation.

Cane sampled in carload lots at mill by the plantation.

EXPERIMENT No. 5—FERTILIZER, NUMBER OF APPLICATIONS.

This was a test to determine the most profitable number of doses in which to apply a given amount of fertilizer. The number of doses varied from two to four.

The fertilizations for the two crops are given below:

1921 Crop—Pounds of Fertilizer per Acre.

Plots	Oct. 1919	Nov. 1919	Feb. 1920	May, 1920	Pounds per Acre N.	Pounds per Acre P_2O_5	Pounds per Acre K_2O
C	500# H.G.*	500# H.G.*	323# N.S.	323# N.S.	200	70	37.5
K	1000# "	0	645# "	0	200	70	37.5
L	500# "	500# H.G.*	645# "	0	200	70	37.5

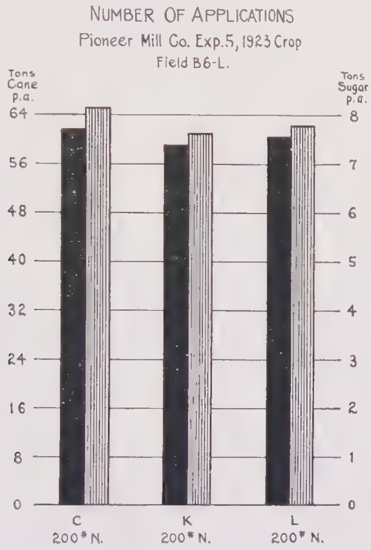
1923 Crop—Pounds of Fertilizer per Acre.

Plots	Nov. 1921	Dec. 1921	April 1922	June 1922	Pounds per Acre N.	Pounds per Acre P_2O_5	Pounds per Acre K_2O
C	500# H.G.*	500# H.G.*	323# N.S.	322# N.S.	200	70	37.5
K	1000# "	0	645# "	0	200	70	37.5
L	500# "	500# H.G.*	645# "	0	200	70	37.5

* H.G.—High Grade—10% nitrogen, 7% P_2O_5; 3.75% K_2O.

The results obtained from the two harvests are given in the following table:

No. of Doses	Tons Cane per Acre 1921 Crop	Tons Cane per Acre 1923 Crop	Tons Sugar per Acre 1921 Crop	Tons Sugar per Acre 1923 Crop	Tons Cane per Acre for two crops
Two doses	49.2	59.1	6.88	7.64	108.3
Three "	48.9	60.7	6.84	7.79	109.6
Four "	49.1	61.9	6.86	8.16	111.0



In the first crop there was no difference whatever in the yields from the different series of plots. The second crop showed slight gains in favor of the larger number of applications. The increase in cane was small, amounting to less than 3 tons per acre. The sugar increase was larger, due to apparently better juices in the "4 dose" plots. We are at a loss to explain these better juices. As a whole, our experience has been the other way, and we would have expected poorer juices from these plots. The variations in cane and sugar yields are well within experimental error.

Taking the average of all our experiments dealing with number of applications we believe that the best results are to be obtained from applying fertilizer in about 3 doses for an 18 to 24 months crop. Three doses are safer than two, and cheaper than four or more, and give about the same yields.

Details of Experiment.

Fertilization—Number of Applications.

Object:

To determine the most profitable number of applications in which a given amount of fertilizer should be applied.

Location:

Pioneer Field B 6.

Crop:

Striped Mexican—1st ratoons.

Previous crop harvested August, 1921.

Layout:

27 plots, each 1/20 acre, consisting of 7 lines by 2 watercourses. Each line 4.5′ wide, 69.15′ long. One guard row along level ditch.

Plan:

Plots	No. of Plots	Pounds of Nitrogen per Acre Nov. 1921	Dec. 1921	Apr. 1922	June 1922	Total Nitrogen per Acre
C	9	50	50	50	50	200
K	9	100	0	100	0	200
L	9	50	50	100	0	200

1st season, mixed fert.—10% N., 7% P_2O_5, 3.75% K_2O.
2nd season, nitrate of soda—15.5% N.

Experiment harvested by J. S. B. Pratt, Jr., in February, 1923, with the help of the plantation.

Cane sampled in carload lots at the mill by the plantation.

Experiments at Makee Sugar Company.

By J. A. Verret

Exp. 1, 1923 Crop

Exp. 2, 1923 Crop

Exp. 3, 1923 Crop

General.

These experiments were laid out in a comparatively low field, 100 feet or so in elevation, but in a rather wind-swept area. The cane was Yellow Caledonia; the tests were carried through three crops, one plant and two ratoon crops. The stand in the last crop, as is generally the case with second ratoons on Kauai, was somewhat irregular. This detracts to some extent from the value of the results obtained from these experiments. On the other hand, we had a rather large number of repetitions of each treatment, ranging from 8 to 14. This has a tendency to correct any irregularities which may creep in due to variations in plot yields. We, therefore, believe that the results can be accepted as fairly accurate.

In Experiment 1, where equal amounts of nitrogen from nitrate of soda, ammonium sulfate, and a mixed fertilizer were compared, the results from three crops show no essential differences in yield, indicating that the best economic policy is to supply nitrogen in its cheapest form. The mixed fertilizer contained 9% nitrogen, 7% phosphoric acid and no potash. The results obtained show that there was no response to phosphoric acid when applied at the rate of 125 pounds per acre.

In Experiment 2 we compared varying amounts of fertilizer. The results for three crops show the economic limit to be from 150 to 175 pounds of nitrogen per acre, about 1100 pounds of nitrate of soda.

In Experiment 3 we tried potash in addition to nitrogen and phosphoric acid. The results indicate some response. More work should be done with potash on this plantation.

EXPERIMENT No. 1—FORMS OF NITROGEN.

This experiment has been carried through three crops, one plant and two ratoons. The cane was Yellow Caledonia. In all cases equal amounts of nitrogen were used on all plots. The mixed fertilizer used contained 9% nitrogen, and 7% phosphoric acid. Each treatment consisted of from 8 to 10 plots, each 1/10 acre in size.

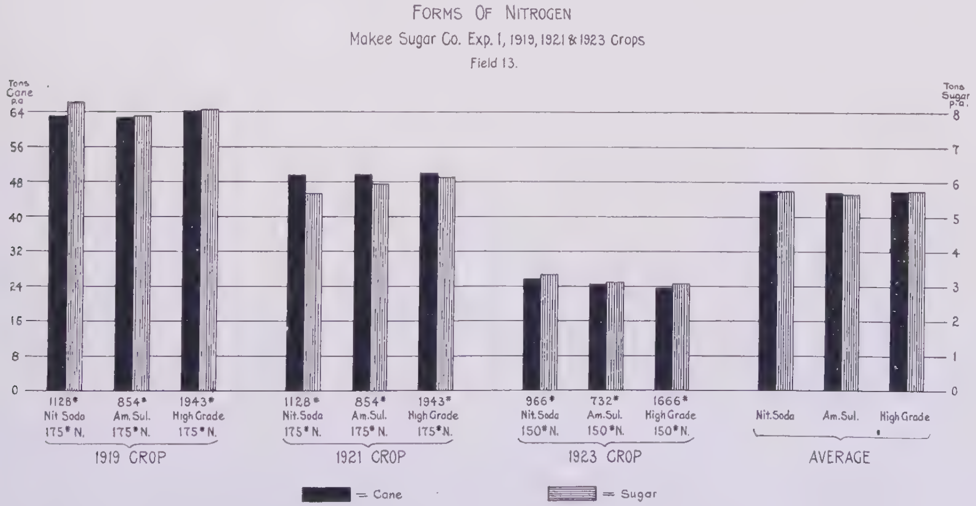
The results obtained from the three crops were as follows:

SUMMARY OF TREATMENT AND YIELDS.

Treatment	Tons Cane per Acre			Average for 3 Crops		
	1919	1921	1922	Cane	Q. R.	Sugar
Nitrate of Soda................	63.1	49.6	25.7	46.1	8.04	5.73
Ammo. Sulphate	62.7	49.8	24.5	45.7	8.07	5.66
High Grade	64.3	50.2	23.7	46.1	7.96	5.78

These results, when averaged for three crops, show no differences in favor of any special form of nitrogen. The High Grade used contained 7% phosphoric acid and was applied at the rate of 1666 pounds per acre, thereby supplying about 125 pounds of phosphoric acid.

The yields from the plots receiving this phosphoric acid were not any more than were the yields from the plots getting nitrogen only. The phosphoric acid in this case was of no benefit.

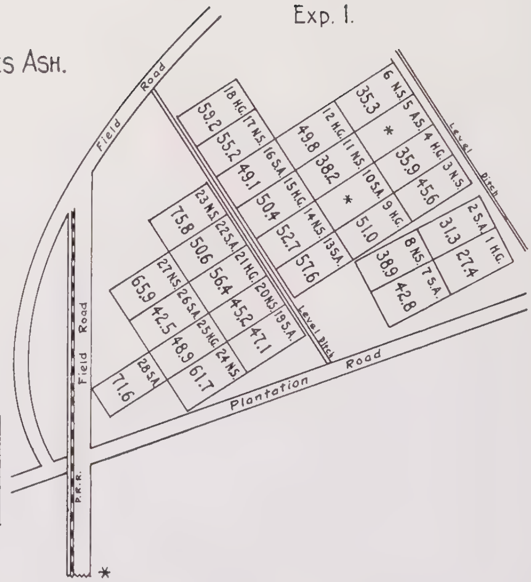


Exp. 1. Forms Of Nitrogen.

Exp. 2. Amount To Apply.

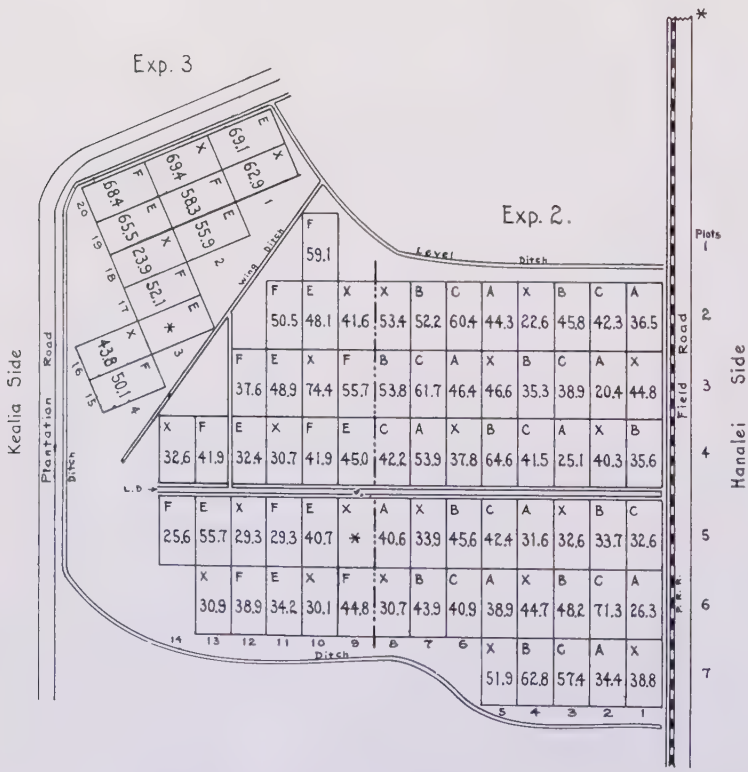
Exp. 3. Molasses Ash Vs. No Molasses Ash.

Makee Sugar Co. Expts. 1, 2 & 3, 1923 Crop
Field 13.



Exp. 1. Summary Of Results

Plots	No. of Plot	Treatment	Yield Per Acre		
			Cane	Q.R.	Sugar
N.S.	10	966 lbs. Nitrate of Soda	25.7	7.74	3.32
A.S.	10	732 lbs. Ammo. Sulphate	24.5	7.88	3.31
H.G.	8	1666 lbs. High Grade	23.7	7.73	3.07



Exp. 2. Summary Of Results

Plots	No. of Plot	Treatment	Yield Per Acre		
			Cane	Q.R.	Sugar
A	11	75 lbs. Nitrogen per acre	18.1	7.82	2.31
X	12	125 lbs. Nitrogen " "	19.9	7.74	2.57
B	11	175 lbs. Nitrogen " "	23.7	7.77	3.05
C	11	225 lbs. Nitrogen " "	24.2	7.94	3.05

Exp. 3. Summary Of Results

Plots	No. of Plot	Treatment	Yield Per Acre		
			Cane	Q.R.	Sugar
X	12	No Molasses Ash	21.3	8.30	2.57
E	11	300* Molasses Ash	24.8	8.31	2.98
F	14	600* Molasses Ash	23.4	8.24	2.84

Details of Experiment.

Forms of Nitrogen

Object:

To compare the results from equal amounts of nitrogen obtained from nitrate of soda, sulfate ammonia, and a high grade fertilizer containing the nitrogen in sulfate, nitrate and organic forms.

Location:

Field 13.

Crop:

Yellow Caledonia, second ratoons.

Layout:

No. of plots, 28. Size of plots, 1/10 acre, 90′ by 48.4′, consisting of 20 straight lines, each 48.4′ by 4.5′.

Plan:

Plots	No. of Plots	Fertilizer	Aug. 1921	Feb. 1922	Total N.
NS	10	Nit. Soda	483	483	150
SA	10	Ammo. Sulf.	366	366	150
HG	8	High Grade	833	833	150

Nitrate of Soda—15.5% Nitrogen.

Sulfate of Ammonia—20.5% Nitrogen.

High Grade—9% Nitrogen (3% Nit. Soda, 3% sul. of amm., 3% organic) 7% P_2O_5 (4% acid phos., 3% bonemeal).

Experiment harvested January, 1922, by O. C. Markwell.

Juices sampled in carload lots at mill by the plantation.

EXPERIMENT No. 2—AMOUNT OF NITROGEN.

In this experiment varying amounts of nitrogen were used, ranging from 75 to 300 pounds per acre for the first two crops and from 75 to 225 pounds for the last crop. Half of the nitrogen used was from high grade fertilizer containing 9% nitrogen and 7% phosphoric acid. This was applied during the first season. The remaining nitrogen applied during the second season was from nitrate of soda.

The cane was Yellow Caledonia. Each treatment was repeated 11 or 12 times on 1/10 acre plots, there being 45 plots in the experiment.

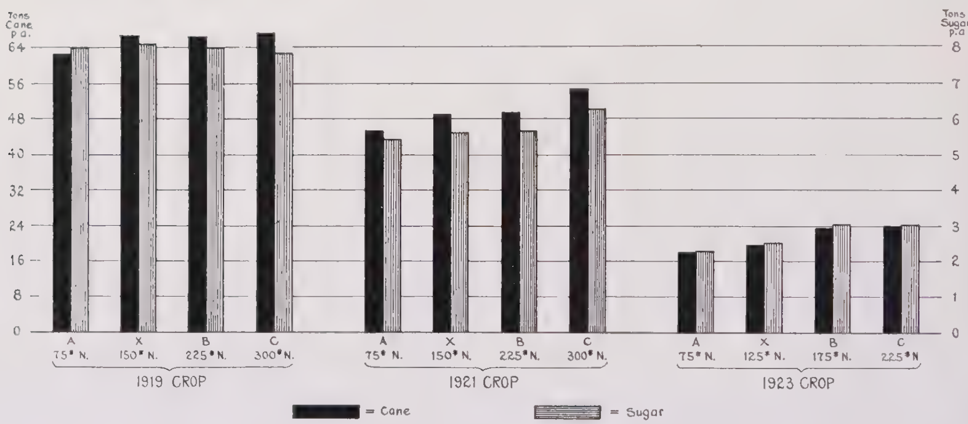
The sugar per acre for the first two crops was as follows:

Treatment		Total Pounds	Sugar per Acre		
High Grade	Nit. Soda	Nitrogen	1919	1921	Average
416 Lbs. p. a.	242 Lbs. p. a.	75	8.03	5.44	6.73
832 " "	484 " "	150	8.14	5.65	6.89
1250 " "	726 " "	225	8.01	5.68	6.84
1666 " "	968 " "	300	7.87	6.28	7.07

The results of the last crop are given as follows:

Treatment		Total Pounds Nitrogen	Yield per Acre		
High Grade	Nit. Soda		Cane	Q.R.	Sugar
416 Lbs. p. a.	242 Lbs. p. a.	75	18.1	7.82	2.31
694 " "	403 " "	125	19.9	7.74	2.57
972 " "	564 " "	175	23.7	7.77	3.05
1250 " "	725 " "	225	24.2	7.94	3.05

AMOUNT OF NITROGEN TO APPLY
Makee Sugar Co. Exp. 2, 1919, 1921 & 1923 Crops
Field 13.



Under the conditions of this experiment the profitable limit of nitrogen application is found to be from 150 to 175 pounds per acre. This would be furnished by, say, 900 pounds of high grade and 550 pounds of nitrate of soda or 1100 pounds of nitrate of soda without high grade. These amounts to be raised or lowered according to good or bad conditions with regard to water, stand of cane, etc.

Details of Experiment.

FERTILIZER EXPERIMENT—AMOUNT TO APPLY

Object:

To determine the most profitable amount of nitrogen to apply at Makee Plantation, 75, 125, 175 or 225 lbs.

Location:

Field 13.

Crop:

Yellow Caledonia, second ratoons.

Layout:

No. of plots, 45. Size of plots, 1/10th acre, 48.4′ x 90′, consisting of 20 straight lines, each 48.4′ x 4.5′.

Plan:

Fertilization in pounds of nitrogen per acre and in pounds fertilizer.

Plots	No. of Plots	August, 1921 # High Grade	March, 1922 # Nit. Soda	Total N.
A	11	416	242	75
X	12	694	403	125
B	11	972	564	175
C	11	1250	725	225

The high grade fertilizer applied in August to have following analysis: 9% nitrogen (3% N. S., 3% Sulfate of Ammonia, 3% Organic) 7% P_2O_5 (4% water soluble, 3% Bonemeal).

Nitrate of soda applied March, 1922, to have 15.5% Nitrogen.

Experiment harvested in January, 1922, by O. C. Markwell.

Juices sampled in carload lots by the plantation.

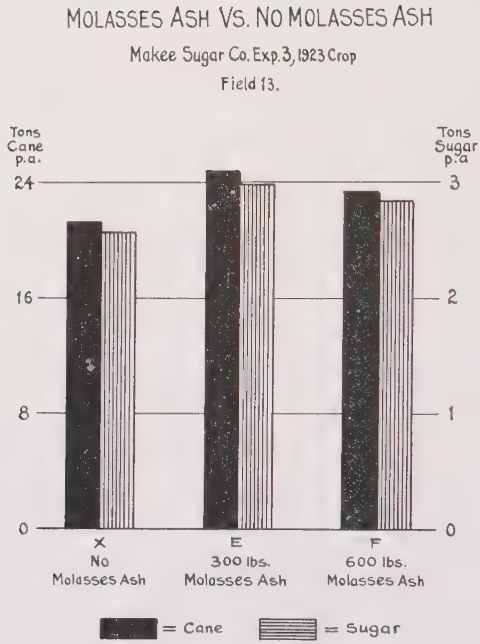
EXPERIMENT No. 3—POTASH FROM MOLASSES ASH.

In this experiment we tried to determine the need of the soil for potash. Molasses ash containing 20% K_2O was applied at the rate of 300 and 600 pounds per acre. The experiment consisted of a total of 37 plots, each 1/10 acre in size. Twelve of these plots did not get any potash, 11 got molasses ash at the rate of 300 pounds per acre and 14 at the rate of 600 pounds. All plots received nitrogen at the rate of 150 pounds per acre from nitrate of soda.

The yields obtained are tabulated as follows:

Treatment	Pounds Potash p. a.	Yield per Acre: Cane	Q. R.	Sugar
No molasses ash	0	21.3	8.30	2.57
300 lbs. molasses ash	60	24.8	8.31	2.98
600 " " "	120	23.4	8.24	2.84

The results here show a response to potash amounting to about 1/3 of a ton of sugar per acre. It is not safe to form conclusions from the results of one experiment, but the indications are that potash rather than phosphoric acid should be used in the high grade applied to all fields similar to the one where the tests were conducted.



Details of Experiment.

Fertilizer Experiment—Value of Potash

Object:

To determine the value of potash in molasses ash on Makee land.

Location:

Field 13.

Crop:

Yellow Caledonia, second ratoons.

Layout:

No. of plots, 37. Size of plots, 1/10th acre, 90′ x 48.4′. All plots have 20 straight lines 48.4′ x 4.5′ except plots 10.4, 10.5, 10.6, 11.4, 11.5, 11.6, 12.4, 12.5, 12.6, 13.4, 13.5, 13.6, 14.4, and 14.5.

Plan:

Plots	No. of Plots	Amount of Molasses Ash
X	12	0
E	11	200#
F	14	400#

150 pounds of nitrogen per acre, from nitrate of soda, applied uniformally to all plots.

Experiment harvested in January, 1923, by O. C. Markwell.

Juices sampled from carload lots at mill by plantation.

Reliability of Optical Sucrose Determination.

By W. R. McAllep and H. F. Bomonti.

During the present clarification investigation the reliability of determination of sucrose in cane juices by the double polarization method was studied by comparing them with sucrose determinations made by a chemical method. Attention was directed to this subject by the increase in purity from clarified juice to syrup at a number of factories after adopting a more alkaline clarification. Such an increase in apparent purity is in part due to the change in the ratio of polarization to sucrose, caused by the action of alkalies at high temperatures on the non-sucrose constituents of the juice. Increases in gravity purity, however, have also been found and these comparisons were made to see if a change in the ratio of optical sucrose determinations, similar to the change in the ratio of polarization, to the actual sucrose content could be detected. Such a change should be shown by comparisons with chemical determinations, as the two methods are based on entirely different principles and it is hardly probable that a factor that might cause an error in one of them would affect the other in the same way.

An excellent opportunity for this study came about when we were working on clarified juices, digesting them at high temperatures. The samples covered a somewhat wider range of acidity and alkalinity than is encountered in ordinary factory practice, and they were from mixed juices varying from .5 to 1.5 per cent glucose.

Optical determinations were made according to the Hawaiian Chemists' Association Methods with Walker's method of inversion. Chemical determinations were based on the reduction of copper, glucose being first determined in the original juice, then glucose plus invert sugar in the juice after inversion. After subtracting the original glucose from glucose plus the invert sugar, the latter was calculated to sucrose. Details of the chemical method follow:

Glucose. Weigh a calculated amount (usually 30 to 35 grams) of juice into a 100 cc. flask, add 1 cc. of neutral lead acetate and 2.5 cc. of 10% disodium phosphate. Make up to 100 cc. and filter. Take a quantity of this filtrate containing 2 grams of total sugars (sucrose plus glucose) in a 400 cc. beaker, add water to a volume of 50 cc. and determine glucose following Munson and Walker's method. For convenience the quantity of juice taken should be such that 50 cc. of the filtrate contains 2 grams of total sugars.

Sucrose. Weigh out 35 to 45 cc. of juice, transfer to a 500 cc. flask using sufficient water to bring the volume to 75 cc. Add 1 or 2 cc. of 6 N hydrochloric acid, heat in a water bath to between 65 to 67° C., add 10 cc. 6 N hydrochloric acid, let stand for one half hour, cool and neutralize with 6 N sodium hydrate. Add 1 cc. neutral lead acetate, 3 cc. 10% disodium phosphate, make up to 500 cc. and filter, adding some dry kieselguhr if necessary to secure a clear filtrate. Take a portion of the filtrate containing approximately, but not more than, 230 milligrams of glucose in a 400 cc. beaker, add water to bring the volume to 50 cc. and determine invert sugar by Munson and Walker's method. From the percent of invert sugar so found subtract the glucose found before inversion and calculate the invert sugar to sucrose, multiplying by the factor .95.

The sample analyzed is small, usually corresponding to somewhat less than 2 grams of the original juice and the greatest care must be taken with details of the manipulation. An error of one milligram in determining the amount of copper reduced, corresponding to approximately half a milligram of invert sugar,

introduces an error of .03 in the sucrose determination. Weighing as cupric oxide did not give sufficiently consistent results so the amount of copper reduced was determined by the following method:

Thiosulphate method. Place the Gooch crucible containing the reduced copper in a 250 cc. beaker with 5 to 10 cc. of nitric acid*, let stand 15 to 30 minutes and filter into a 300 cc. Erlenmeyer flask, washing the crucible and mat thoroughly with hot water. Evaporate on a hot plate to 50 cc., add 1.5 grams of washed neutral talcum powder and boil 5 to 10 minutes longer. Cool, add 2 cc. of concentrated sulphuric acid and 10 cc. of a saturated solution of potassium iodide. Titrate with a sodium thiosulphate solution standardized against pure copper. A convenient strength is 1/5 normal. The end point is sharp and titration should be made to .1 or if possible .05 cc. The thiosulphate solution used in this work was the equivalent of 13.14 milligrams of copper per cc.

Sucrose was determined by both optical and chemical methods before and after digestion, in the juices of four of the digestion experiments. Experiments 2 and 8 were clarification series in which portions of mixed juice were limed to different reactions, boiled, filtered with kieselguhr and digested at 180° F. Experiment 13 was a single portion of juice clarified in the same way but digested at 200°. 16 was the same as 13, except that the digestion temperature was 212. The time of digestion in all cases was 22 hours. The analyses are arranged in table 1, light faced figures being analyses before and dark faced figures analyses after digestion.

Before examining the data further, we will touch briefly on the behavior of the juice during digestion and the limits of accuracy in the methods employed. Clarified juices change in reaction when held at high temperatures, becoming more acid. Of the juices, the analyses of which are shown in table 1, three reached neutrality or acidity to litmus, the rest remaining alkaline to this indicator. Even though most of them did not become actually acid to litmus, their reaction was sufficiently acid so that inversion of sucrose, indicated by a distinct increase in the glucose content, took place in all with the exceptions of juices 4 and 5 in Experiment 2, and possibly 3 in Experiment 8.

With respect to the accuracy of the determinations, the actual inversion, which was formerly the greatest source of inaccuracy in such methods, can probably be accomplished with close to absolute accuracy with the Walker method. Both the optical and chemical methods, however, require several manipulations and measurements, none of which are of absolute accuracy, particularly in the absence of elaborate equipment for temperature control. A study of the probable effect of these inaccuracies indicated .05 as a reasonable limit of error in a single determination and .1 in a comparison involving two determinations, one by each method. The latter figure corresponds to a difference of some .7 in purity. As this is large in proportion to any probable size of the factor we are studying, conclusions cannot be drawn from individual determinations, but must be based on averages.

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* One part of concentrated acid to two parts of water.

TABLE I.—OPTICAL AND CHEMICAL SUCROSE DETERMINATIONS.

Light faced figures are the analyses before and heavy faced figures the analyses after digestion.

			Sucrose		Reaction*		
	Brix	Glucose	Optical	Chemical	Litmus	Phenol-phthalein	PH
Experiment 2—Before and After Digesting 22 Hours at 180° F.							
Filtered mixed juice ...	13.54	0.63	11.50	11.51	.010	.062	5.73
#1 Clarified–2.5 cc. lime	14.01	0.68	11.80	11.79	.004	.042	6.24
	13.97	**1.08**	**11.48**	**11.41**	**.008**	**.051**	**5.99**
#2 Clarified–5 cc. lime	13.75	0.67	11.80	11.80	.003	.032	6.78
	13.82	**0.76**	**11.75**	**11.69**	**.002**	**.031**	**6.41**
#3 Clarified–7.5 cc. lime	13.60	0.64	11.71	11.69	.008	.016	8.18
	13.62	**0.68**	**11.76**	**11.75**	**.003**	**.016**	**6.86**
#4 Clarified–10 cc. lime	13.71	0.63	11.84	11.81	.011	.002	8.55
	14.00	**0.64**	**12.12**	**12.05**	**.005**	**.012**	**7.25**
#5 Clarified–12.5cc. lime	13.64	0.59	11.87	11.87	.014	.002	8.69
	13.77	**0.60**	**11.99**	**11.95**	**.012**	**.008**	**7.34**
Experiment 8—Before and After Digesting 22 Hours at 180° F.							
Filtered mixed juice...	13.65	0.58	11.85	11.91	.010	.050	5.73
#1 Clarified–5 cc. lime	13.71	0.62	12.05	12.04	.006	.020	6.91
	13.80	**0.72**	**11.97**	**11.97**	**.001**	**.025**	**6.58**
#2 Clarified–7.5 cc. lime	13.82	0.60	12.16	12.20	.008	.008	7.60
	13.89	**0.63**	**12.17**	**12.22**	**.002**	**.013**	**7.01**
#3 Clarified–10 cc. lime	13.92	0.59	12.32	12.31	.010	.004	8.27
	13.97	**0.60**	**12.29**	**12.34**	**.004**	**.008**	**7.42**
#4 Clarified–12.5cc. lime	13.83	0.54	12.21	12.27	.011	.002	....
	13.92	**0.59**	**12.19**	**12.23**	**.005**	**.007**	**7.34**
#5 Clarified–15 cc. lime	13.76	0.51	12.21	12.18	.012	.001	....
	13.81	**0.57**	**12.20**	**12.24**	**.005**	**.001**	**7.42**
Experiment 13—Before and After Digesting 22 Hours at 200° F.							
Clarified juice	15.10	0.25	13.97	13.98	.012	.002	8.57
	15.11	0.75	13.25	13.51	.0	.009	6.85
Experiment 16—Before and After Heating 22 Hours at 212° F.							
Clarified juice	13.28	1.60	10.63	10.61	.018	.002	8.8
	13.33	**4.26**	**8.01**	**8.04**	**.018**	**.020**	**5.22**
Average			11.90	11.90			

* Underlined figures indicate acidity.

Table 2 is an analysis of the figures in table 1. The first, second and third columns are respectively the difference between optical and chemical determinations on mixed juice, clarified juice and clarified juice after digestion. The fourth column shows the change in the relation of the optical to the chemical sucrose during clarification, and column five shows the change during digestion. A plus sign in the first three columns indicates that the optical was greater than the chemical determination, and a plus sign in the fourth and fifth column indicates that the optical determination increased in proportion to the chemical during clarification and digestion respectively.

TABLE II.—DIFFERENCES BETWEEN OPTICAL AND CHEMICAL SUCROSE DETERMINATION

Plus signs in the first, second and third columns indicate that the optical exceeded the chemical determination and in the fourth and fifth columns that the optical determination increased in proportion to the chemical.

		Before Clarification	After Clarification	After Digestion	Change during Clarification	Change during Digestion
Experiment #2	Juice #1	—	+.01	+.07	—	+.06
22 Hours at 180 F.	" #2	—	0	+.06	—	+.06
	" #3	—	+.02	+.01	—	—.01
	" #4	—	+.03	+.07	—	+.04
	" #5	—	0	+.04	—	+.04
	Average	—.01	+.01	+.05	+.02	+.04
Experiment #8	Juice #1	—	+.01	0	—	—.01
22 Hours at 180 F.	" #2	—	—.04	—.05	—	—.01
	" #3	—	+.01	—.05	—	—.06
	" #4	—	—.06	—.04	—	+.02
	" #5	—	+.03	—.04	—	—.07
	Average	—.06	—.01	—.04	+.05	—.03
Experiment 13, 22 Hours at 200 F.		—	—.01	+.01	—	+.02
Experiment 16, 22 Hours at 212 F.		—	+.02	—.03	—	—.05
	Averages	—.03	+.002	+.004	+.03	+.002

The maximum difference shown in the first three columns of table 2 is .07, corresponding to .5 in purity; a figure smaller than the estimated probable error, but still large enough to prevent drawing conclusions from individual comparisons. The maximum change during clarification or digestion (columns 4 and 5) also does not exceed the estimated limit of error.

If digesting alkaline juices at high temperatures causes an increase in the optical sucrose determinations in comparison with the actual sucrose content, assuming for purposes of comparison that the chemical determination represents the actual sucrose, plus values will be found in the fifth column. There should also be a tendency for the more alkaline juices in Experiments 2 and 8 to show the greater plus values. The average of the fifth column is indeed a positive value, plus .002, corresponding to between .01 and .02 purity. This is small enough to be considered negligible. The figures in the second and fifth column show no pronounced tendency toward greater plus values in the more alkaline juices. We may then conclude that any error in the optical sucrose determination caused by

the alkaline digestion is too small to be detected by the methods employed and that it may be considered negligible.

Data secured during the digestion experiments throw further light on the reliability of the optical sucrose determinations. Analyses of 63 juices, including sucrose and glucose determinations before and after digestion, are available. In one sample only was there any indication of destruction of glucose and in this case the amount did not exceed reasonable limits of error. With no destruction of glucose, the total sugars before and after digestion should be in agreement if the accuracy of the analyses is not affected by the digestion. Averages of these analyses follow. The figures in the last column are the analyses after digestion calculated back to the density of the juice before digestion.

	Before Digestion	After Digestion	After digestion Corrected for evaporation
Brix	14.517	14.540	14.517
Sucrose	12.695	12.575	12.555
Glucose	.641	.785	.784

Total sugars after digestion, corrected for evaporation, are 13.339. This includes .143 invert sugar formed during digestion, from which 5% must be deducted to calculate it back to the original sucrose. Subtracting this 5%, amounting to .007 from 13.339, we have 13.332 total sugars after digestion against 13.336 before digestion. The difference .004, corresponding to .03 in purity, is negligible. It is, however, in the opposite direction to the small difference that was found in the comparisons with chemical sucrose determinations.

Both the optical and chemical methods will give the true sucrose content in a pure solution for it is on this that they are based. It is possible, however, that impurities can cause an error in either, but that such entirely different characteristics, as the rotation of a ray of polarized light and the reduction of copper, should be affected to the same extent and in the same way is quite improbable. The averages of all the determinations, shown in table 1, are identical. While there is a possibility of compensating errors, the close agreement strongly indicates that the results found coincide closely with the true sucrose content.

The possibility that clarification might cause a change in the optical determination has not been thoroughly studied, as other work has so far prevented investigation of this subject. Chemical determinations were made on the mixed juices in experiments 2 and 8. The differences before and after clarification are arranged in columns 1, 2 and 4 of table 2, in a similar manner to the differences before and after digestion in the same table. Though two determinations are not sufficient data on which to base conclusions, taking the figures as they stand, we find a plus difference in column four of .03. Again assuming the chemical determination to correspond with the correct sucrose content this would indicate an apparent increase in purity of .2, due to error in the optical determination. If, however, such an error actually exists it should be more pronounced in the more alkaline members of a clarification series. On the whole, figures in the second column do not give a definite indication that this is the case, rendering it somewhat improbable that the error actually exists. Unfortunately, comparison cannot be made of the total sugars before and after clarification as was done before and after digestion, for the available analyses cannot be corrected for evaporation during clarification. The error, if it actually exists, is small, probably not affecting the gravity purity more than two or three tenths.

While this work was not carried to the point where we can state positively that no change in optical sucrose determinations is caused by clarification, it does give us definite information as to the reliability of optical determination when clarified juices are further heated. As no material change in the relation of the optical to chemical sucrose determinations has been found, and as the total sugars before and after digestion are in close agreement, we can conclude that in clarified juices, limed within the limits practicable in factory work, digestion at high temperatures does not cause an error in optical sucrose determinations, and further, the fact that the two methods have given identical results strongly indicates that the optical method gives the actual sucrose content of the juice. A corollary to these conclusions is that increases in gravity purity from clarified juice to syrup are not to be attributed to errors in the method of analysis.

Preparation of Cane Fibre Samples*

By John P. Frank

The influence of the fiber content of the cane on all the other control figures is well understood. The importance of closer observation of the analysis of this constituent, the method of sampling the cane ground, and the procedure in preparing the cane samples lead the writer to conduct experiments along these lines.

Each day two parcels of cane were selected as samples and labelled A and B. Each parcel was subsampled as directed in hand book of "Methods of Chemical Control" and two analyses were made on each parcel, one prepared with a disintegrator, and the other prepared with a Japanese plane. All samples received the same amount of washing, pressing and drying. The following are the results obtained. (Figures on the same line represent the same parcel of cane):

RESULTS OF FIBER ANALYSES

	Disintegrated Sample	Planed Sample	Difference
June 14.	13.25	13.00	
	11.85	11.35	.38
15.	13.00	11.40	
	11.20	11.10	.95
16.	12.50	12.60	
	13.85	13.50	.12
21.	13.35	12.30	
	13.50	12.20	1.17
22.	13.95	12.05	
	13.45	12.25	1.55
23.	13.60	12.60	
	14.45	12.05	1.70
24.	13.50	11.95	
	12.10	10.95	1.35
26.	13.65	12.85	
	13.40	12.50	.85
27.	12.05	10.90	
	13.65	13.10	.85

* Presented at first annual meeting of the Association of Hawaiian Sugar Technologists, Honolulu, November 15-18, 1922.

RESULTS OF FIBER ANALYSES (Continued)

	Disintegrated Sample	Planed Sample	Difference
June 29.	11.10	12.90	
	13.40	12.25	.22
30.	12.85	12.35	
	14.40	14.20	.35
July 1.	12.75	12.10	
	12.85	11.60	.95
6.	12.75	10.20	
	12.80	12.25	1.55
7.	12.95	12.50	
	14.20	11.95	1.35
10.	12.30	11.75	
	11.65	11.85	.17
11.	12.50	11.55	
	12.20	11.55	.80
Total Av.	12.97	12.11	
Plus	0.70 for fiber in trash	0.70	
	13.67% fiber in cane	12.81%	.86

The above figures given by the two methods differ by 0.86. As the cane was of the same quality in both cases, the question would naturally follow, "Why the difference?"

The writer found that cane samples, after passing through the disintegrator, were divided into two portions, one long and stringy and the other derived from the pith in a fine mealy state of division. On mixing such a sample, it was found that a large portion of the fine mealy particles sift through the long stringy fibrous portion and settle on the bottom.

A number of experiments conducted by Noel Deerr, indicate that the fiber content of the pith of the cane is one third of the fiber contained in the rind and nodes. In the writer's analyses on disintegrated cane, the samples weighed for analysis were not representative, but without doubt, on account of the tendency of the mealy particles of pith fiber to sift to the bottom, contained too great a proportion of the long, stringy node and rind fiber.

It is not the writer's intention to suggest a particular make of machine for the purposes of disintegration or preparation of the cane fiber sample, but a desire to call the attention of those interested to the fact that, in this particular step in the fiber determination, the chance of introducing errors is great.

In conclusion, the writer maintains that the sample should be in a uniform state of division. If a disintegrated sample is not of a uniform state of division, the subsample weighed out for analysis will not, in the majority of cases, be representative of the original sample.

A Description of the Air Lift Pump*

By George Duncan

An air lift pump installation which has been completed at Olaa may be of some interest.

This installation consists of two air lift pumps, which replaced two plunger pumps of about 200,000 gallons per 24 hours each. The two wells were drilled in 1904 for supplying the mill with water for condenser purposes. Previous to this time it depended absolutely upon the cane flumes for its water supply. This was rather an uncertain factor, and at times failed entirely.

In 1904 arrangements were made to drill two 12″ wells, 240 feet deep, and install two 8″ single acting deep well plunger pumps. The elevation of the mill is 220 feet above sea level. Water was struck at 203 feet below the ground level, this then gave 37 feet of standing water when drilling was discontinued.

As these pumps gave considerable trouble, especially at the time they were most urgently needed and as the requirements of the mill increased from year to year, means had to be devised whereby the water supply might be increased. The scarcity of water was further augmented when a paper mill was installed in 1919.

We were certain there was an abundance of water at or near sea level, because from an average yearly rainfall of 200″ there is practically no surface drainage in the territory extending from Hilo to Kau. This is due to the porous condition of the soil which is of comparatively recent volcanic origin. Also all along the coast large quantities of fresh water pour into the sea all the year round. From this we were justified in deciding upon the air lift pump as the most economical means for getting this additional water supply.

For the benefit of the few who may not know the basic principles of the air lift pump it might be well to give a brief description of this system of pumping.

Description

Pumping water by means of the air lift system is not a new invention or idea and hundreds of installations are to be found scattered throughout different parts of the world.

Very little seems to have been written on this subject and it is hard to get hold of any formulas and tables for making the proper calculations in connection with the different installations. Manufacturers of these air lift pumps must have collected a vast amount of data from their own private experiments and from the results of the systems they have installed. Yet there seems to be a reluctance on their part to give out these formulas.

One of the best articles on this subject I have seen so far is "The Air Lift," by Prof. A. H. Blaisdell, Pittsburgh, in "Power," November 23rd, 1920. All of the formulas given here are taken from this article with the exception of the efficiency formula which does not appear in the article but is by the same author.

The standard terms used in air lift work together with the definition of same is herewith given:

* Presented at first annual meeting of the Association of Hawaiian Sugar Technologists, Honolulu, November 15-18, 1922.

Static Head:

Normal water level when not pumping.

Drop:

Point to which the water level drops while being pumped.

Pumping Head:

Level of water when pumping as compared to ground surface.

Static Head + Drop = Pumping Head.

Elevation:

Point above the ground surface to which water is being raised.

Lift:

Distance water is elevated from level when pumping, to point of discharge and includes Elevation + Static Head + Drop = Lift.

Submergence:

Depth of the air pipe below the pumping head.

Starting Submergence:

Depth of the air pipe below the Static Head.

Drop + Submergence = Starting Submergence.

100 Per Cent:

The vertical distance the air travels with the water from point of introduction to point of discharge.

Figure 1 shows this in diagramatic form.

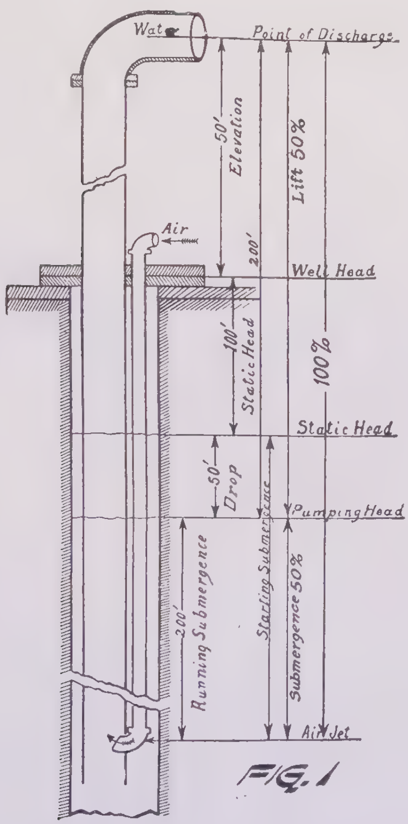


FIG. 1

In its simplest form the air lift pump consists of a pipe submerged in a column of water and a smaller pipe delivering air into it at the bottom. The theory is that if the water inside the pipe is to be induced to rise higher than the water on the outside, means must be devised to lower the specific gravity of the column of water as a whole contained within the pipe. Then the greater relative weight of water on the outside would tend to force the lighter column upwards.

What could be simpler for this purpose than the introduction of air?

In order to obtain a fair degree of efficiency, means must be devised to have a thorough mixture of the air and water. If the air is introduced in a haphazard way it has a tendency to form into large bubbles which drive through the water without doing their useful share of work. The slip of the bubbles constitutes the chief loss of energy. This varies as the square root of the volume of the bubbles. It is therefore desirable to reduce the size of them by any possible means.

In 1886 when Dr. J. G. Pohle obtained U. S. patents involving this system, he worked on the theory of alternate plugs of air and water, with the pipes submerged 60%. The highest efficiency he obtained was from 20 to 25%. Since that time improved methods of construction have more than doubled this figure. This has involved the thorough and continuous mixing of the air and water, proper proportioning of the discharge or eduction pipe and giving the installation the proper amount of submergence; all of these facts having been obtained by costly experiments.

Figure 2 shows the original Pohle or Side inlet pump or foot-piece, while Figure 3 is the Pohle annular foot-piece. In this foot-piece the air fills the annular space surrounding the eduction pipe and is free to enter the rising column

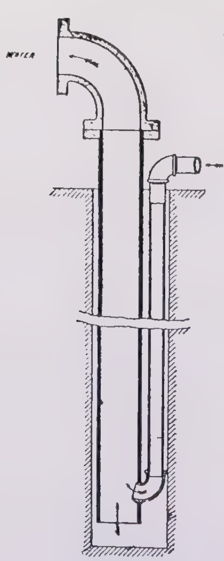


FIG. 2

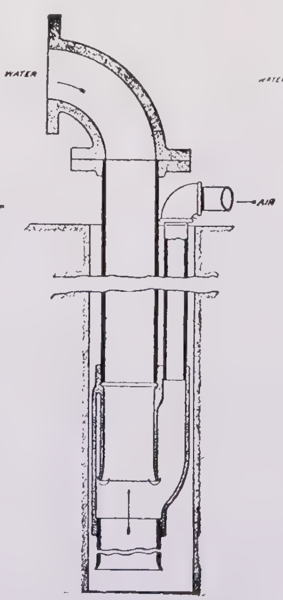


FIG. 3

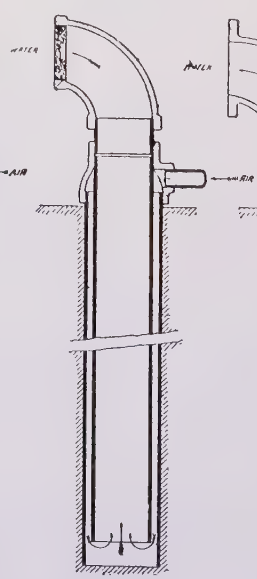


FIG. 4

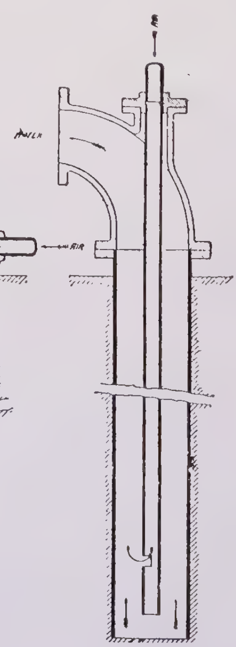


FIG. 5

at all points of its periphery, at the same time acting without obstructing or contracting the discharge pipe anywhere.

Figure 4 shows the Saunders or Reservoir system. In this system the well has to be cased all the way down and a little past the point where the air enters the eduction pipe. It is used in wells which will not permit the use of the side inlet on account of lack of space.

Figure 5 shows the Central Pipe system which is just the reverse of the arrangement described.

In none of these systems has there been any attempt made to mix the air and water thoroughly, with the result that the efficiency has been low, owing to the discharge being a succession of air bubbles and plugs of water. According to the Sullivan Machinery Co., the cause of this is as follows: "Pressure is built up in the air passage (until it is sufficient to overcome the head due to submergence) when a large bubble of air passes into the eduction pipe. This flow of air from the pipe temporarily reduces the air pressure through wire drawing, so that the weight of water in the well outside of the eduction and air pipes, which is due to submergence, shuts the air off and a plug of water follows

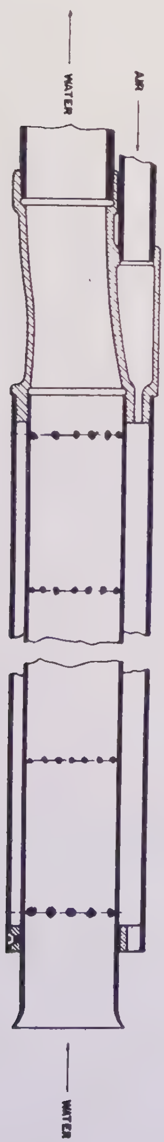


FIG. 6

FIG. 7

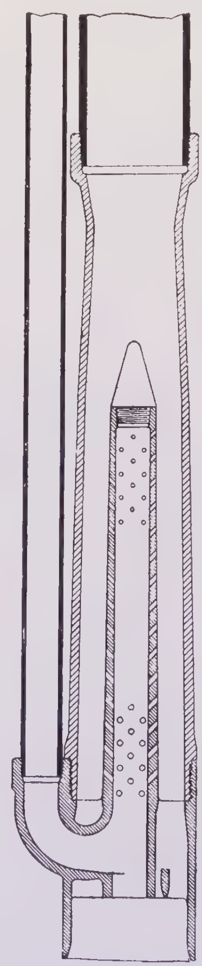


FIG. 8

the plug of air up into the eduction pipe, until the compressor has had time to build up the air pressure and the air again breaks through."

All of these systems have been more or less superseded by more up to date and efficient methods.

Figure 6 shows the Ingersoll-Rand Class V. A. foot-piece which is the type installed at Olaa. As will be seen, the annular feature has been retained but considerably improved upon. It consists of an outside casing with an inside tube of brass, both attached to the Venturi connection which helps to mix the air and water and give the proper acceleration at this point. The Venturi or throat is important and is used in all up to date foot-pieces. The foot-piece is made long enough to permit a series of rings of small holes to be drilled around the periphery of the brass tube. These rings of holes are spaced in such a way as to create sufficient back pressure in the pump so that the air will enter the rising column of water with some speed, thereby again insuring a more thorough mixing with the water. It also helps to overcome the "plugging" effect as described in the older systems.

Figure 7 shows the Central Pipe system made by the same company. This system is practically the same as that just described, the only difference being the introduction of the air through the central pipe. All the other features of the V. A. foot-piece are retained in this style of pump.

Figure 8 shows the Sullivan Standard Air Lift Pump, built by the Sullivan Machinery Company, Chicago. The foot-piece is in the same class as the Ingersoll-Rand V. A. type. The characteristics are practically the same, the only change being the introducing of the air in the center of the rising column of water instead of on the outside.

Figure 9 is the Central Pipe system by the same company. The sketch shows very plainly the throat or Venturi.

Figure 10 shows the Sullivan Type D foot-piece for 8″ and larger sizes. This is a combination of the annular and central systems. It has been found that in the larger sizes of pumps the thickness of the stream of water prevents the air—escaping through the perforations in the central mixing tube—from making a thorough mixture. Therefore by the addition of the outside tube this is overcome.

Although the efficiency of an air lift pump be low, it is probably as high, if not higher, than any other apparatus used to lift water from narrow and deep wells. It is remarkably free from liability to breakdown as there are no valves or any moving parts to get out of order. Stones or sand are no obstacles to it. When our installation was first started numerous stones were thrown out, some of them about 2″ diameter and one piece in particular was about 2½″ diameter by 4″ long. The well can be any distance from the air compressor, provided of course consideration is given to the size of the air pipe leading from the compressor to the well. It requires no attention whatever as it will start and stop as the compressor is started and stopped. This extreme simplicity and the lack of attention required, has a tendency to offset any of its disadvantages.

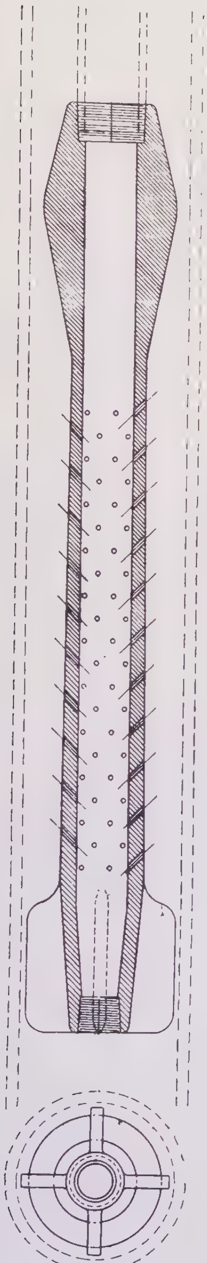
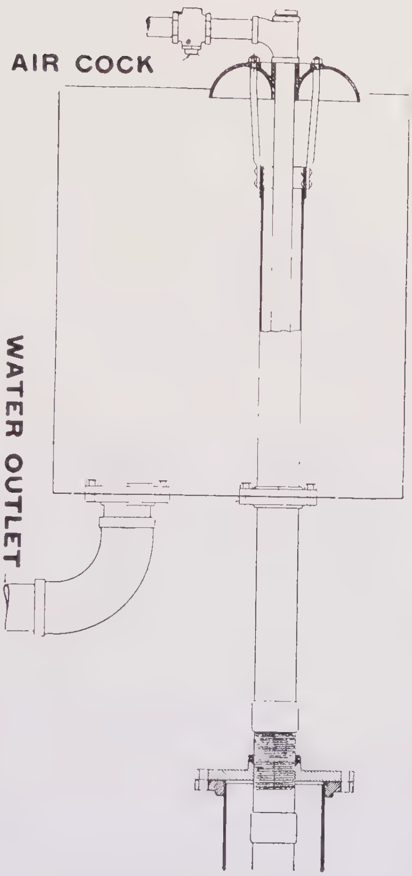


FIG. 9



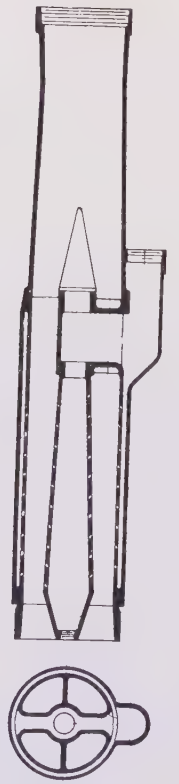


FIG. 10

Water can also be pumped through long horizontal pipes from the air lift proper and again forced to an elevation above the ground surface. This is done by installing a booster on the top of the discharge pipe and using the air a second time after being separated from the water.

Figure 11 shows the Sullivan "Cyclone" Booster while Figure 12 shows the Re-lift Mixing Tube. Figure 13 shows a typical installation, illustrating the air lift, booster and re-lift mixing tube or compound jet.

The booster as illustrated is a simple tank, closed top and bottom, with the inlet and outlet at a tangent to the periphery. The combined air and water from the air lift is discharged into the top at a high velocity, causing it to swirl and effecting in this way a perfect separation of air and water. The water is discharged at the bottom, while the air passes off at the top through the pressure

FIG-11

FIG-12

retaining valve. This valve is set to maintain the pressure required by the head against which the booster is to discharge. The air from the pressure retaining valve is piped to the bottom of the riser pipe where it again mixes with the water through the re-lift mixing tube.

The work to be done by the booster, represented by the lift and friction head, should not exceed 25% of the total working air pressure in the air lift pump.

It is unfortunate that there is no data available at this time in connection with the combined efficiency of the air lift and booster.

To operate efficiently the proper amount of submergence or that part of the air and eduction pipes below the surface of the water in the well, is very important.

In actual practice it has been found that the submergence may be varied with the lift, shorter lifts requiring a greater percentage of submergence. The drop of a well is one of the most uncertain factors in air lift work and cannot be calculated previous to installing the pump. Each well is a separate problem, because (depending on the geology) one well may have a drop of 40 feet while

another may have no drop at all. Owing to this and also on account of the depth of the well and proportioning of the eduction pipe, there is no definite relation between lift and submergence, although the following proportions will be found effective for preliminary calculations:

For lifts to	50 feet	— 70 to 66%	submergence
	50 to 100 "	— 66 to 55%	"
	100 to 200 "	— 55 to 50%	"
	200 to 300 "	— 50 to 43%	"
	300 to 400 "	— 43 to 40%	"
	400 to 500 "	— 40 to 33%	"

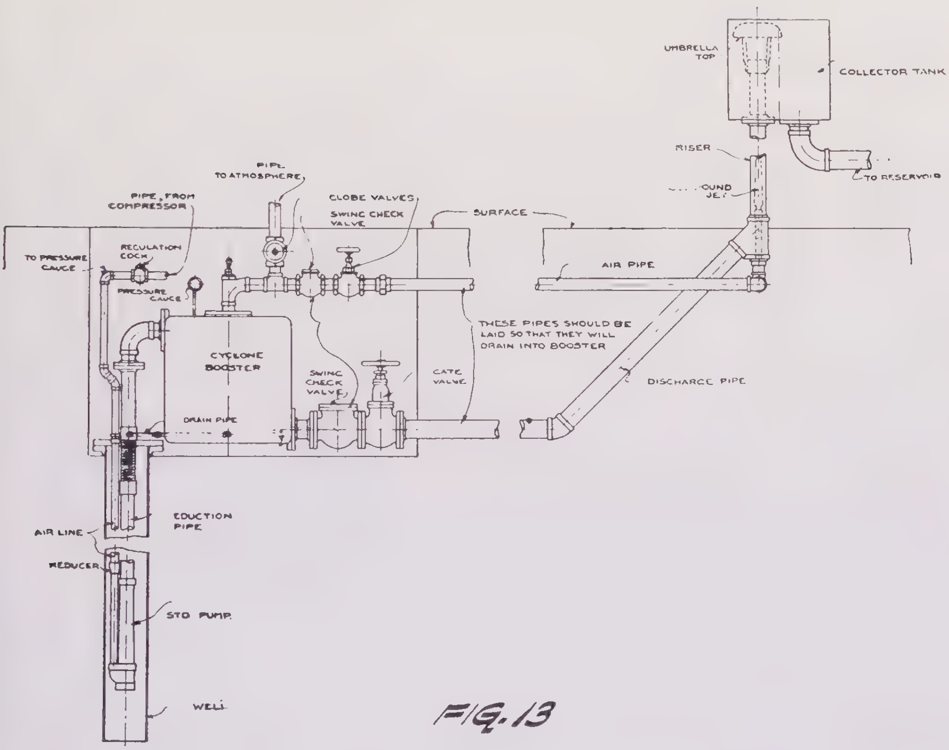


FIG. 13

The proper proportioning of the eduction pipe is also of great importance to secure the highest efficiency. It must bear a relation not only to the amount of water to be handled, but also to the amount of air; so that for an equal amount of water the pipe size may vary with the lift and also with the percentage of submergence, as both factors change the amount of air. If the pipe is too large, there is slippage of the air past the water unless more air is used to keep up the velocity. If the pipe is too small, undue friction will, of course, increase the power needed.

Quoting Prof. Blaisdell: "The velocity of the air and water mixture at the upper end of the discharge pipe will be from three to four times that in the lower portion of the same pipe (if the pipe is of constant diameter throughout)

due to the expansion of the air bubbles as they ascend in the discharge pipe and reduce the effective area for the flow of water. It will serve for most purposes to assume a velocity of from 6 to 8 feet per second for the lower end of the pipe and 18 to 26 feet per second for the upper end." The theoretically correct form of discharge pipe is one that tapers gradually from top to bottom.

Some of the formulas used in air-lift work are here given. In these formulas the letters have the meaning as follows:

Q = Cubic feet per second of water and air.
Qw = Cubic feet per second of water pumped.
q = Cubic feet free air per gallon water pumped.
q_1 = Cubic feet free air per lb. water pumped.
p_1 = Atmospheric pressure lbs. per square ins. abs.
p_2 = Pressure at lower end of air pipe, lbs. per sq. ins. abs.
V = Velocity of fluid mixture at point where air enters discharge pipe, ft. per second.
D = Diameter of discharge pipe in inches.
G = Gallons water pumped per minute.
h.p. = Lift in feet.
N. = % Efficiency.

The quantity of water and air passing by the lower end of the air pipe is given by the formula:

$$Q = Qw\left(7.84\ q\ \frac{p1}{p2} + 1\right)$$

This formula applies to but one section of the discharge pipe, for any section of this pipe y feet from the lower end of the air pipe, the density of the fluid mass is less than it was lower down in the pipe and Q becomes greater, although the weight of fluid discharging from the pipe per second remains constant.

The diameter of the discharge pipe is given by the formula:

$$D = 0.62\sqrt{\frac{G\left(7.48\ q\ \frac{p1}{p2} + 1\right)}{V.}}$$

The value of D given by this formula must be less than that of the well by 3″ to 5″. A suitable value for V is 6 to 8 feet per second. As a rough estimate one can allow about one square inch of free cross sectional area for discharge for every 12 to 18 gallons of water pumped.

Quantity of free air per gallon of water pumped is given by the formula:

$$q = \frac{62.5\ \text{h.p.}}{N\ 16035\ \log_e \frac{p2}{p1}}$$

The efficiency of an air lift can best be stated as:

$$N = \frac{\text{lbs. of water delivered} \times \text{pumping head in feet}}{\text{air compressor work in foot lbs.}}$$

For given operating conditions this ratio will be the same for unit weight of water as for the total weight, providing that the quantity of free air per lb. of water pumped is used in the calculation. Therefore this becomes:

$$N = \frac{1 \times \text{h.p.}}{144\ p_1\ q_1 \log_e \frac{p2}{p1}}$$

For other formulas in connection with the effective length of the discharge pipe and proportioning of same see the before mentioned article in "Power" by Prof. Blaisdell.

Olaa Installations and Results

The Olaa installation consists of one Ingersoll-Rand 10″ and 10″x14″, and 16″ and 10″x14″ steam driven cross compound air compressors and two type V. A. size 8 foot-pieces.

The two original wells of 240′ depth in which the single acting plunger pumps worked, were deepened to 450′. This was necessary to obtain the proper submergence.

The dimensions of the wells are as follows:

Diameter		12″
Depth	450′	0″
Static Head	203′	6″
Drop	0′	0″
Pumping Head	203′	6″
Submergence	239′	1½″
% Submergence	54	

It will be noted that there is no drop of the static head. This, I believe, is very unusual, but, as was said before, when everything is taken into consideration with reference to the geology, it is not so remarkable.

The two wells are within fifty feet of each other so that this favors our contention that there was an abundance of water. The wells are about three miles inland but the salt contents of the water is only 0.4 of 1 grain per gallon.

The dimensions of the discharge pipes of the two pumps are as follows:

Well No. 1

Length of Foot Piece..................	6′	10″
First section of pipe 4½″ diameter......	50′	0″
Second " " " 5″ "	127′	1″
Third " " " 6″ "	124′	9-5/8″
Fourth " " " 7″ "	133′	10-7/8″
Total	442′	7½″

Well No. 2

Length of Foot Piece..................	6′	10″
First section of pipe 4½″ diameter......	119′	10-7/8″
Second " " " 5″ "	139′	11-7/8″
Third " " " 6″ "	175′	10-3/4″
Total	442′	7½″

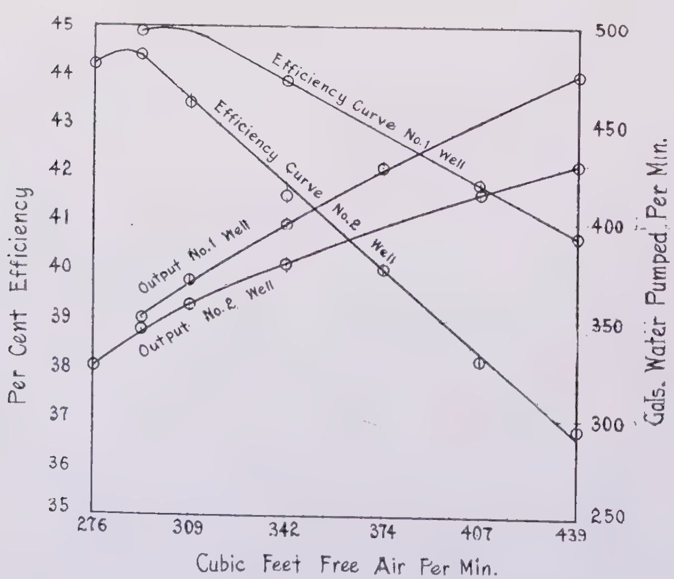
It will be seen that the discharge pipes of the two pumps are not alike. If the efficiency and output chart Figure 14 is studied, the influence, which the proper proportioning of the discharge pipe has on the amount of work done by the pump, will be apparent at once.

The wells were pumped at different compressor speeds varying from 276 to 439 cub. ft. free air per minute, to determine the most economical speed and also to find out the greatest amount of water we could expect if we had occasion to need it.

The following is the result of these tests:

No. 1 Well

Air	Water			Air
Cub. ft. per min.	Gals. per min.	Gals. per 24 hrs.	Gals. per Cub. ft. air	Cub. ft. per Gals. water
293	350.99	505,425	1.196	0.835
309	370.04	532,857	1.193	0.836
342	400.09	576,129	1.171	0.855
374	428.30	616,752	1.143	0.875
407	452.75	651,967	1.111	0.899
439	476.01	685,461	1.082	0.942



—Efficiency & Output (Gals. Water Per Min.)—
Of
—Wells No.1 & No.2 Olaa Hawaii—

FIG. 14.

No. 2 Well

Air Cub. ft. per min.	Water: Gals. per min.	Water: Gals. per 24 hrs.	Water: Gals. per Cub. ft. air	Air Cub. ft. per Gals. water
276	325.86	469,238	1.176	0.849
293	346.70	499,248	1.182	0.846
309	357.65	515,016	1.151	0.865
342	378.40	544,896	1.106	0.904
374	399.00	574,560	1.064	0.939
407	415.40	598,176	1.020	0.980
439	430.40	619,776	0.978	1.022

The air pressure required is of course that due to the submergence. Submergence $\div$ 2.3 + friction = Running pressure.

The efficiency of the two pumps as computed by Prof. Blaisdell's formula is:

Air Cub. ft. per min.	% Efficiency Pump #1	% Efficiency Pump #2
276	——	44.22
293	44.97	44.44
309	44.93	43.41
342	43.90	41.57
374	42.96	40.02
407	41.76	38.35
439	40.67	36.78

Acknowledgment is hereby made to the Ingersoll-Rand Co. and Sullivan Engineering for the illustrations used.

Potash Recovery From Waste Molasses*

By Raymond Elliott.

Molasses has been burned at Paauhau during this season for the recovery of ash and potash. A specially constructed furnace is used, the molasses being fed in the form of a thick spray. An analysis of the resulting ash by the H. S. P. A. Experiment Station gives the following as the composition of three months' run:

	Per Cent.
Potash, water soluble	27.66
Potash, acid soluble	28.33
Silica	3.63
Iron and Aluminum Oxides	1.22
Lime	17.67
Phosphoric Oxide, acid soluble	2.00
Phosphoric Oxide, water soluble	trace
Sulphuric Oxide	8.36
Carbon Dioxide	5.39
Chlorine	16.49
Carbon	11.79
Total Water Soluble	55.28

* Abstracted from a paper read at the first annual meeting of the Association of Hawaiian Sugar Technologists, Honolulu, November 15-18, 1922.

The following table gives the results of the operation for three consecutive months. The first two columns show the recovery of ash and potash respectively as per cent of theoretical. The third and fourth columns show respectively the actual potash per cent of the ash and the theoretical potash per cent of ash as obtained from laboratory analysis. In the fifth column is shown the percentage difference between the theoretical and actual potash content of the ash, corresponding to the per cent of the total potash lost.

Ash Recovered, % Ash in Molasses	Potash Recovery, % Potash in Molasses	% Potash in Ash — Actual	% Potash in Ash — Theoretical	Percentage Difference
41.37	32.89	22.60	28.43	20.5
59.24	53.06	25.25	28.19	10.4
72.28	60.11	27.61	33.20	16.8
89.19	79.34	27.74	31.18	10.3
79.00	71.84	27.66	30.42	9.1
87.96	73.48	26.35	31.55	16.5

The order of recovery of ash, potash and the potash content of the ash follows fairly regularly. The writer has observed that this is a direct result of the draft and heat of the furnace, the best recovery following the use of a low draft not to exceed 0.10″ and a low temperature, just sufficient to effect the combustion of the molasses. This is readily explainable by the fact that at relatively high temperature the chloride of potassium, which forms the bulk of the potash salts, is volatilized, a fact which is also shown in the low potash content of the ash when the recovery is also low.

Sugar Loss Due to Burning-Off*

By J. P. Frank.

When cane is burned before cutting, there is found on the stalks a sticky substance, the amount varying with the intensity of the heat to which it has been exposed, being greatest when the cane is unstripped and the trash dry. This so-called "sweating" was examined in the laboratory of the Onomea Sugar Co., and found to be concentrated juice, thus indicating a loss in sugar due to burning in addition to that possibly lost through deterioration of the cane. This is particularly so when the cane is sent to the mill in flumes, when the material on the stalks will be entirely dissolved in the flume water. The work here reported was interrupted by a spell of rainy weather, and is therefore not complete. It is the intention of the writer to make further tests and observations during the 1923 crop. The following figures give the results obtained so far:

Condition of Cane and Fire.	Sucrose in "Sweating" per 100 Sucrose in Cane.
Unstripped Cane, light fire, light burning, wet trash (1)	0.81
" " " " " " " " (2)	0.81
" " light burning	0.96
" " wet trash	1.18
" " normal fire	2.35
" " hot fire (1)	6.08
" " " " (2)	7.46
Stripped Cane, light fire	0.79
" " hot fire	2.43

* Abstracted from a paper read at the first annual meeting of the Association of Hawaiian Sugar Technologists, November 15-18, 1922.

Returning Mud to the Mill After the First Pressing*

By V. Marcallino

The idea of returning the mud to the mill after its separation from the clear juice is an old one, and has been tried out in many varying forms. The results claimed vary from absolute failure to complete success.

At Waiakea, the experiment of returning mud to the mill after the first pressing was started at about noon on Friday, August 18. It was continued all day Saturday and on Monday, the 21st, until 4 p. m. The immediate cause of its discontinuation was the difficulty encountered in getting the juice to settle in the clarifiers, resulting in the blocking of this station.

Double pressing is practiced at Waiakea. It was thought that after one pressing and remixing with water, the volume of the mud juice would have been so reduced as to make its return to the mill possible, also that its sucrose content would be so low that there would be no effects harmful to the extraction.

Object of the Experiment.

Four men are employed on the mud press station, two on the first presses, two on the second. Had the experiment been successful, it would have meant the elimination of two men and of all the cloth used in the second presses. In 1921, with a crop of 9380 tons, the quantity of cloth used on the second presses alone was 1720 yards. A certain amount of inversion is always to be found where double pressing is practiced. This should have been reduced.

Procedure.

There was no change made in the equipment, other than the running of a pipe from the pump supplying the second presses to the mill. This pipe was lead into a trough located just behind the first mill and here the mud juice mingled with the last mill juice, the overflowing of the trough causing the mixture to sprinkle over the bagasse blanket.

The mud juice, after the first pressing, and the last mill juice being of approximately equal densities, it was felt that this was the proper place to return the mud. The time allowed for the admixture of the mud and bagasse blanket was therefore the time taken by the bagasse blanket to travel between the first and second mills. As the crusher was not in use at the time of the experiment, the second mill juice went directly to the mixed juice tank.

Results.

It was noted that a considerable proportion of the mud returned was re-expressed by the second mill and reentered the mixed juice. The increased volume of mud in the clarifiers retarded the settling to such an extent as to greatly lessen the proportion of clear juice which could be drawn off, and at the

* Presented at the First Annual Meeting of the Association of Hawaiian Sugar Technologists, Honolulu, November 15-18, 1922.

same time, increased the quantity of mud to be handled by the first presses. This resulted in the congestion of these two stations and was the immediate cause of the discontinuation of the experiment.

The above is true in spite of the fact that the average tonnage per hour for these three days was only 21.3, as against 25.0 for the balance of the crop, and that out of a total time of 37 hours there were delays amounting to 3 hours and 45 minutes, which time was available for settling. The dilution, however, for these three days averaged 32.3 as against 27.5 for the balance of the crop.

Bagasse samples taken during the period of the experiment both when the mud was being returned and when such was not the case, point to the conclusion that the extraction would have suffered somewhat, had the procedure been continued. To just what extent, however, the writer would not care to hazard a guess, owing to the short duration of the test and the lack of conclusive figures.

It may also be noted that during the progress of the experiment, several complaints were encountered from the firemen, who claimed that the bagasse did not burn as well, owing to a higher moisture content and the presence of the mud.

Discussion of the Results.

It seems that the principal reason for the failure of the experiment was that a large proportion of the mud once removed from the clarified juice found its way back into the mixed juice, resulting in an ever increasing volume of mud in the settling tanks. In other words, the bagasse blanket of one mill alone did not constitute a proper filtering medium, a large proportion of the mud finding its way into the expressed juice instead of being retained in the bagasse.

Had the mud juice been returned after the second mill instead of after the first, the last mill juice containing the expressed mud could have been returned ahead of the second mill, probably resulting in a better filtration. It was felt, however, that the returning of the mud juice high in sucrose content just ahead of the last mill, would have had a detrimental effect on the extraction. Or, if the crusher had been in operation at this time, the second mill juice could have been returned ahead of the first mill. It is possible that with a longer train of mills, where the returning of maceration could be practiced, a more satisfactory filtration could have been obtained.

It may be noted that during the progress of the experiment the juice from the clarifiers was more strongly alkaline than is usually the case at Waiakea. No attempt was made to speed up the rate of settling by decreasing or increasing the amount of lime used.

Sugar Formation and Ripening of the Sugar Cane*

By J. Kuyper.

(abstracted by W. van H. Duker)

The first part of this publication describes how the formation of organic matter depends on the leaf green (chlorophyl) and the light energy.

The quantity of light energy is fixed and the growing period should be so arranged that this quantity is used to best advantage. Everything in connection with the crop must be so arranged that as large a quantity as possible of the leaf green (chlorophyl) is exposed to the light; it is therefore of advantage to a variety when it has a deep green color, an overhanging foliage and a wide leaf. For this reason healthy cane has the advantage over yellow stripe diseased cane, because the latter contains less chlorophyl. The plant shape should be so that the entire surface is covered by leaves.

Binding of canes works detrimentally on the production ability, because as the tops are tied together the light energy is not fully utilized. Tying up is therefore a cure for fallen cane, which at times can turn out to be definitely detrimental.

Under otherwise comparable circumstances high cane weight usually goes together with a lower rendement, a lower cane weight with a higher rendement. However, a favorable year in comparison with an unfavorable one will give a higher rendement, because favorable weather conditions give to the cane a better chance to ripen. Early harvesting is nearly always less risky than late harvesting.

In the second part the ripening and ripeness determination is treated. In the first place the sampling is discussed. The best system is a definite location on a field map of the spots where the samples are to be taken, and long before the samples are analyzed to label the stalks to be used. The choice of the stalks is therefore perfectly automatic. It is immaterial if the stalks originate from one or more seedpiece. The reliability of this method is discussed in detail.

In Chapter III, on the analysis of the samples, is first proven that sampling for cane weight is practically impossible and that therefore the juice figures deserve our special attention. Later they take up why the three-division of the stalks is the best method of analysis. In detail is described how this method is developed and on what scientific base it rests. The division of the stalk in 10 parts gives interesting data but is too elaborate for practical use; examination of 2 parts causes the most important advantages of the division method to be lost. The method does not hold good for just a few varieties; but, based on physiological reason and on examples taken from practice, the conclusion is drawn that between cane varieties no principal difference exists.

In Chapter IV, on the Interpretation of Advance Analyses Results, methods are developed how the figures from the advance analysis books can best be combined to obtain a survey of the available material. The fields are therefore arranged in groups with the same plant month. From the thus obtained figures it is shown how the ripening depends on the plant month; for 100 P.O.J. this

* Archief voor de Suikerindustrie in Nederlandsch Indie, 1922.

dependability is greater than for 247 B; for the factory at Remboen the figures check closer than for Gempolkrep. The curves for the average sucrose content is also different for both plantations, but from this the conclusion is drawn that the ripening differs for cane varieties and plantations. It is shown that two main groups of plantations must be considered; those where soil and climate are favorable to a slow ripening in the east monsoon, and those where soil and climate first accelerate ripening in the east monsoon but thereafter break off quite suddenly. On the first named plantations later planted fields can reach the same rendement as the earlier planted; in the latter group the later fields usually only reach a lower rendement. The influence of the climate on the ripening for different years is traced.

Chapter V deals with the differences between the three parts where in the stalk is divided. Here also the just mentioned division holds good. It shows that on a plantation with a strong east monsoon for all canes, irrespective of the plant month, the differences of lower-center equal the difference of center-top, that therefore in the graphic representation the lines cross at about the same datum. For a plantation of the Remboen type this is not the case.

It happens repeatedly that the difference of lower center becomes negative, and more especially for certain cane varieties as D.I. 52, for others less so, and for 247 B practically never. The connection of this phenomenon with the rainfall is shown. The comparison between the plantations Remboen and Gempolkrep is again extensively carried through on the basis of what is said in previous chapters. At the end of this chapter a review is given of the behavior of several cane varieties on different enterprises; while a classification is studied of how far cane varieties and enterprises should be arranged in the before mentioned groups.

In Chapter VI a study is made as to how W.S. (available sucrose) Brix and Purity change in the three parts of the stalk under the influence of outside circumstances, especially rain. It shows that the lower part reacts first and strongest on minor factors such as light rains. The Purity shows the strongest fluctuations of irregularities in the ripening, a large drop of Purity in all parts points to large disturbances, especially if this coincides with a drop in the Brix. The character of the reaction of the juice is the same for varying age, and therefore in order to determine the moment of ripeness next to these variations in juice properties, the characteristics of every cane variety and each plantation must be known.

In Chapter VII, on the glucose, we find that the glucose factor shows variations in nearly perfect agreement with the fluctuations in the usually determined juice figures. Based hereon is reasoned that the determination of the glucose percentage has only doubtful value considering the additional work required.

In connection with the Specific Gravity in Chapter VIII, we find that up to the present this has been of no value in the determination of the time of ripeness, also the chance that this will give a better indication in the future is small. At its best it furnishes a control on certain characteristics in the stand (for instance, presence of diseased cane) and only as study material do the Specific Gravity determinations have value.

Investigations Pertaining to the Field Rat and Other Problems in Hamakua.

A Report on Progress of Work

By C. E. Pemberton

On January 5th of this year, I commenced an investigation of the results obtained from the application of rat poison in all of the cane fields at Honokaa during the year 1922. As each field is harvested, I am making counts of average cane in all parts of the field to obtain as exact figures as possible on the amount of rat damage present. I have made every effort to secure a fair count. I believe the accumulating data will fall close to the average condition of each field. The preliminary results have reached fair proportions, and I am submitting them at the present time for the interest they possess. The accompanying table summarizes the results. For interesting comparisons I am including a table on the extent of rat damage at Honokaa to cane, cut during 1922, which was unpoisoned excepting in limited areas under experiment. These figures were kindly supplied me by the Honokaa Sugar Co. I have also added a table showing the enormous amount of rat damage occurring in cane at Pacific Sugar Mill, cut during 1922. These figures were also supplied by Honokaa Sugar Co. I have made a few counts with Mr. F. R. Giddings, of cane harvested this year at Pacific Sugar Mill, and include them in the first table. The treatment for rat control of the fields at Pacific Sugar Mill does not seem to have been satisfactory. The amount of rat-eaten cane now present there would also seem to indicate this. The control in some sections will be difficult and require very close supervision in the application of poison. It will probably prove necessary to place poison in those parts in greater quantity and more frequently than in average fields, both at Honokaa Sugar Co. and Pacific Sugar Mill. The condition of the fields at Pacific Sugar Mill will thus this year serve to some extent as a check on the results obtained at Honokaa, where the poisoning during 1922 was intensively done and thorough in most areas.

The average damage to cane harvested to date at Honokaa, as computed from the data in Table 1, is 3.2%. The fields from which this cane was cut were poisoned thoroughly in 1922. The average damage by rats to cane at Honokaa harvested during 1922, as taken from Table 2, was 19%. This cane was not poisoned, except experimentally in some places. This comparison is highly illuminating and rather indicates that the first year of the poison campaign at Honokaa, with all its seemingly insurmountable difficulties and doubts as to the final results, has proven an economic success. There should be much greater improvement during the coming year through more efficient manufacture of the poison, its more systematic application, and through much added knowledge of the distribution and habits of the rat and the quantity of poison to apply. Table 1 shows parts of some fields still with from 5 to 15% rat injury. These places are almost invariably next to gulches or are deep hollows or pockets containing rock-piles or waste areas of great irregularity. Here the rats have a better

foothold, can develop and congregate with but little disturbance, and it is here that poison will need to be applied in maximum quantity and frequency. The parts of Honokaa fields showing the most injury received about the same amount of poison as the less damaged parts. The quantity and frequency of application will probably have to be doubled at such places in the future. Field 38, Honokaa, shows some places with a fair amount of rat damage, in spite of the poisoning I am told that this cane was in some parts fairly mature before the first application of poison was put on, and that rat injury was then present. This does not account for all the injury, however, Several fields will show a good deal of old injury, owing to the age of the cane. Field 34 is now being harvested. This field is two years old and had considerable rat-eaten cane in it before the first poison was put on in 1922. It seems to illustrate very well the efficacy of the poison, for practically all of the injury is old.

Most of the Honokaa fields which were poisoned received three applications. Mr. F. R. Giddings of Honokaa Sugar Co. has given me the data included in Table 4, showing just what treatment each field received. It should be noted that strychnine-wheat was not applied until the close of the year and thus practically all of the results were obtained from the first two treatments with barium carbonate cakes. I believe four applications a year in average fields will prove worth while, instead of three. At least the first two should not be more than three months apart. A consideration of the breeding habits of the rat must be taken into account. Three months after the first poisoning, many young rats which were too small to move about much for food when the first application was made, will have missed the poison, which the adults have readily found, and be old enough for reproduction. This brood, just maturing, will be important to eliminate as far as possible. In other words, the quantity of young left in the field after the first poisoning should be large, while the number present at the time of the second poisoning, three months later, should be small. This is the basic principle governing the artificial control of many insect pests, and should hold true in rat control, within reasonable limits, if the poisoning is thorough.

Bubonic plague has again appeared among rats in Hamakua, the first for the year 1923. Mr. C. Charlock of the Territorial Board of Health has diagnosed the cases of three rats as positive for plague. Two came from Field 19, Pacific Sugar Mill, and one from the Louisson-Vanatta Road above Paauilo. It is interesting that all three rats were taken outside the region at Honokaa where the rats have been so greatly reduced. Rats have done a great deal of damage in Field 19, Pacific Sugar Mill, where two of the infected individuals were taken. Mr. Charlock has supplied me with slide mounts of the plague bacilli secured from these three plague rats. They are proving useful for comparison with numerous bacteria which I am daily securing from fleas and mites collected from rats, for plague investigations.

Cane Borer Damage

While carrying on the systematic examination of cane for rat injury as it is cut in each Honokaa field, I have been constantly confronted with rather extensive cane-borer injury. I have been making counts in each field since February

7th, to secure the percentage of borer-injured cane. The injury is in excess of what was expected. In fact, the damage by borer this year must amount to many thousands of dollars if the percentages continue to run as high as those obtained in the counts to date. I have used every precaution to count only average unselected cane. The following table covers all the examinations made. Mr. Waldron and Mr. Naquin are particularly interested in having me secure these data. I have been told that the borer has always been somewhat serious here.

BORER-INJURED CANE, HONOKAA SUGAR CO., 1923

Date	Field	Variety	No. Sticks Examined	No. Sticks Injured	Percentage Injured
Feb. 7	30	D 1135	200	107	53.5
" 8	18	H 109	100	36	36
" 8	18	D 1135	100	58	58
" 9	18	"	100	32	32
" 12	37	"	200	101	50.5
" 12	30	"	100	63	63
" 13	30	"	100	49	49
" 14	37	"	300	132	44
" 14	30	"	100	39	39
" 15	18	"	200	39	19.5
" 16	19 (Kukuihaele)	"	100	29	29
" 17	18	"	200	30	15
" 19	34	H 109	300	174	58
" 20	34	"	600	244	40.6
				Average	41.9

Parasitized borers are easily found in any field, but for some unexplained reason, the parasite does not hold the borer in check as well as on most other plantations in the Islands. As the examinations for rat-injury progress, I will collect with these data further information on the extent of borer-injury in each field as it is harvested.

Wireworm Investigations

Two field experiments on wireworm control have been put out, using cyanamid and carbon bisulphide. A field for the cotton-seed meal experiment should be ready for planting in a few weeks. The cyanamid experiment covers an area 80 by 60 yards, using 400 lbs. of cyanamid, placed in the furrow with the seed before it is covered. I placed this in the furrows ahead of the planters, spreading it well out to cover the bottom of the furrow at a width of about 1½ feet. Suitable check-rows were untreated. I do not believe the cyanamid will prove of any value in checking wireworms. It has no effect upon them that I could detect in laboratory experiments. Fifty wireworms were placed in a 2-quart can of soil on January 16th and two ounces of cyanamid mixed thoroughly in. This is a much greater strength than could ever be used in the field. On February 20th, the wireworms were still healthy and active, barring those which had been destroyed through the cannibalistic habits of the wireworms. In another laboratory test on January 12th, 100 freshly-collected wireworms were placed in a wooden box containing ½ cubic yard of soil into

which 4 ounces of cyanamid was thoroughly mixed, and 4 seedpieces of D 1135 planted. This is at a rate of over 1 ton cyanamid per acre. By February 20th, the cane had germinated satisfactorily, the root-systems were large with no visible cyanamid injury, and the wireworms were still alive and active. None of the cane-eyes had been eaten by the wireworms, however, after the 39 days of confinement in the box with the seed. The material may have had some injurious effect upon the wireworms which could not be detected. The cyanamid may thus act as a repellant. The field experiment will require a few weeks more before the results are known.

In the carbon bisulphide test against wireworms I gassed 22 rows, 150 feet long, following the planters, leaving proper check-rows, using the Danks Injector and applying about 1 gallon of carbon bisulphide per 500 feet of row. A charge of gas was put in at about 1½ feet spacing. I hoped in this way to kill outright the majority of the wireworms in the soil for a distance of about 1½ feet about the seed. It is yet too early to know the results of this test.

TABLE 1.

RAT-DAMAGE—HONOKAA SUGAR CO.

FIELDS POISONED 1922—HARVESTED 1923.

Field	Variety	Date 1923	No. Sticks Examined	No. Sticks Rat-eaten	Percentage Sticks Eaten
20	H109 & D1135	Jan. 5	1500	10	.6
	" "	" 6	500	1	.2
	Badila	" 17	1000	0	0
	D1135	" 17	1000	29	2.9
	"	" 17	*2000	22	1.1
33a	H109 & D1135	" 22	2000	22	1.1
	H109	" 26	1400	56	4.0
	"	" 27	2000	59	2.9
	D1135	" 27	600	10	1.6
30	D1135	" 9	500	6	1.2
	"	" 10	1000	8	.8
	"	Feb. 5	*1000	35	3.5
	"	" 6	3000	57	1.9
	"	" 7	2000	49	2.4
	"	" 12	1500	119	7.9
	"	" 13	1000	84	8.4
	"	" 14	1000	35	3.5
13	"	Jan. 17	*2000	1	.05
	"	" 25	3000	31	1.03
	"	" 30	3000	35	1.01
37	"	Feb. 7	2000	81	4.05
	"	" 12	2000	88	4.4
	"	" 14	2000	82	4.1
38	"	Jan. 10	2000	51	2.5
	"	" 23	1000	51	5.1
	"	" 24	1000	64	6.4
	H109	" 24	1000	22	2.2
	"	" 29	1500	229	15.2
	"	" 30	1000	99	9.9
	D1135	" 30	1000	105	10.5
	H109	Feb. 5	*1000	119	11.9

Field	Variety	Date 1923	No. Sticks Examined	No. Sticks Rat-eaten	Percentage Sticks Eaten
18	"	Jan. 23	3000	74	2.4
	"	" 24	*2000	51	2.5
	"	" 29	2000	39	1.9
	D1135	" 29	2000	65	3.2
	"	Feb. 4	1700	37	2.1
	"	" 5	1300	46	3.5
	H109	" 8	3000	37	1.2
	D1135	" 8	3000	30	1.0
	"	" 9	1000	29	2.9
1a	"	" 15	2000	5	.2

EXAMINATIONS AT KUKUIHAELE (PACIFIC SUGAR MILL).

Field	Variety	Date 1923	No. Sticks Examined	No. Sticks Rat-eaten	Percentage Sticks Eaten
9	H109	Jan. 13	1300	221	17.0
19	D1135	" 13	*1340	345	25.8
	D1135	Feb. 5	*1500	590	39.3
	Striped Tip	" 16	*2000	962	48.1

* Count made with Mr. F. R. Giddings.

TABLE 2.

RAT-DAMAGED—HONOKAA SUGAR CO.
CANE HARVESTED 1922—UNPOISONED

Field	Date 1922	No. Sticks Examined	Percentage Sticks Eaten
2	May	2800	24
33	"	1000	15
37 B	"	900	25
Chow Choy Contract	"	300	31
1	June	1300	15
2	"	900	26
21	"	300	10
27	"	2000	21
33	"	2500	17
37 B	"	100	22
Chow Choy Contract	"	800	22
1	July	1300	18
21	"	300	14
27	"	1500	16
33	"	1200	16
17	August	600	11
19	"	1400	19
21	"	800	13
24	"	1200	21
27	"	2200	29
28	"	700	16

TABLE 3.

RAT-DAMAGE—PACIFIC SUGAR MILL.
CANE HARVESTED 1922—UNPOISONED.

Field	Date 1922	No. Sticks Examined	Percentage Sticks Eaten
6	June	700	39
8	"	1800	37
14	"	1500	34
23	"	1200	31
5	July	400	10
8	"	1100	55
9	"	300	78
14	"	1800	29
13	August	600	26
5	"	1100	17
24	"	2800	40
22	"	500	7
9	"	800	67
9	September	500	40

TABLE 4.

RAT-POISON APPLICATION, YEAR 1922—HONOKAA SUGAR CO.

Field	Date	Poison	Date	Poison	Date	Poison
1a	June 17	Barium-Carbonate	Nov. 7	Barium-Carbonate	Dec. 20	Strychnine Wheat
5	May 22	"	" 11	"	" 21	"
6	July 19	"	" 9	"	" 21	"
7	" 31	"	" 8	"	" 22	"
10	" 18	"	Oct. 25	"	" 28	"
11	" 19	"	" 30	"	" 22	"
12	" 22	"	Nov. 4	"	" 23	"
13	" 26	"	" 6	"	" 24	"
17	May 31	"	" 2	"	" 20	"
18	" 25	"	Oct. 30	"	" 19	"
20	" 20	"	" 24	"	" 21	"
25	June 15	"	" 20	"	" 27	"
26	" 17	"	" 21	"	" 22	"
28	" 26	"	" 23	"	" 24	"
29	" 30	"	" 19	"	" 27	"
30	July 12	"	" 13	"	" 22	"
33a	May 29	"	" 23	"	" 19	"
34	Mar. 22	"	" 10	Strychnine Wheat	" 8	"
36	June 14	"	" 16	Barium-Carbonate	" 30	"
37	" 30	"	" 4	"	" 22	"
38	July 8	"	Sept. 30	"	" 18	"

Note: Fields 28 and 29 were treated (partially) with strychnine-barley on April 26 and March 11 respectively.

Mongoose

I believe mongoose could be greatly reduced about houses and camps where they destroy poultry, by the adoption of a method which I have tried here with the mongoose in captivity. I have repeatedly killed them, without a single failure, by giving them dead mice poisoned with from 1 to 2 grains of potassium cyanide. I have frequently noticed how quickly, in the field, a mongoose finds and eats a dead rat or mouse. In one instance I had placed a quantity of rat poison in a certain field and early on the following morning counted 18 dead mice close to the poison, in various parts of the field where it was placed. The mice were not touched and on the second day were again looked for. The entire 18 were missing and mongoose excrement, full of hair, was found at a number of the poison spots. This same sort of observation has been made many times during the past 8 months. These observations led to confined experiments, using dead rodents into which a strong poison, such as potassium cyanide, had been inserted. I found that mice are best for this purpose, since the mongoose usually gulps it down dog-fashion, swallowing everything, including head, teeth, claws and all. By making a small incision in the abdomen and inserting a piece of cyanide the size of a pea, or somewhat less, an ideal bait was made. The mongoose never rejected the bait and always died after eating it. They will readily eat a dead mouse if it has not commenced to decay. For those who cared to go to the trouble of setting a few traps for mice, treating the freshly-caught mice as above described and then placing them in places outside poultry yards, where the mongoose have been seen, I believe profitable results would follow. In cane fields where rats are destructive, the mongoose does more good than harm, both in the destruction of rodents and insects.

I have tried feeding the mongoose with rats and mice which have died from eating strychnine-wheat and barium carbonate cakes. The dead rodents are readily eaten, but there is no poisoning effect on the mongoose. One individual was fed 42 mice poisoned and killed with strychnine-wheat or barium carbonate cakes and one rat poisoned with barium carbonate, between October 30, 1922, and November 22, 1922. It remained healthy and active the entire period and completely consumed the rodents whenever they were given. This individual was then killed in a few hours' time by feeding it a mouse containing potassium cyanide. Usually the mongoose will not readily eat poisoned beef.

Any poison procedure for mongoose, if followed as above, would, of course, be dangerous to dogs, cats, etc., that might pick up the poisoned, dead rodent, while potassium cyanide is a dangerous poison to man, even in small quantities.

The assertion is frequently made that the mongoose will eat cane. I have been unable to induce a mongoose to eat cane, even when nearly starved. I have tried cane containing borer-grubs and likewise secured only negative results.

March, 1923.

Safety Involved in Use of Pressure Gages*

Proper Location, Well Arranged Connection Scheme, and Frequent Testing of Gages Necessary for Safe Operating Conditions.

As a part of the high pressure piping system, gages, their use, installation and care are of importance from the standpoint of safety as well as the operating viewpoint. Although progress has been made in gage manufacture until these instruments are quite rugged and extremely reliable, nevertheless there are certain points which must be considered which add to their accuracy and therefore to the over-all safety of the plant.

In its report, the Boiler Code Committee of the A. S. M. E. has this to say regarding steam pressure gages: "Each boiler shall have a steam gage connected to the steam space or to the water column or its steam connection. The steam gage shall be connected to a siphon or equivalent device of sufficient capacity to keep the gage tube filled with water and so arranged that the gage cannot be shut off from the boiler except by a cock placed near the gage and provided with a tee or lever handle arranged to be parallel to the pipe in which it is located when the cock is open. Connections to gages shall be of brass, copper or bronze composition.

"Where the use of a long pipe is necessary, an exception may be made to the rule that the gage must be arranged so that it cannot be shut off except by a cock placed near the gage and a shutoff valve or cock arranged so that it can be locked or sealed open may be used near the boiler. Such pipe shall be of ample size and arranged so that it may be cleared by blowing out. The dial of the steam gage shall be graduated to not less than one and one-half times the maximum allowable working pressure on the boiler. Each boiler shall be provided with a ¼-in. pipe valved connection for the exclusive purpose of attaching a test gage when the boiler is in service, so that the accuracy of the boiler steam gage can be ascertained."

One method of making the gage connections and which conforms to the recommendations just cited is that shown in Fig. 1. In this scheme, as is frequently the case, provision has been made at the top of the water column for the gage connection. The cross A is used and a valve B is placed in the gage line. At C is the section of the piping that provides the water seal and prevents the steam from coming in contact with the gage mechanism. Arrangement for a test connection is made by placing an angle valve at D.

Quite frequently it is desired to place a high pressure steam gage on a central board located on the boiler room floor. This is permissible if done in accordance with the rules given by the A. S. M. E. Code.

One such scheme is shown in the left-hand part of Fig. 1. In this case, the valve E must be locked in the open position and it is also necessary to make provision for blowing out the pipe line. The valve J can be closed, valve E closed and plug G removed, which allows the water to drain out. Valve E may then be opened and the line blown out. The line may then be filled with water at F.

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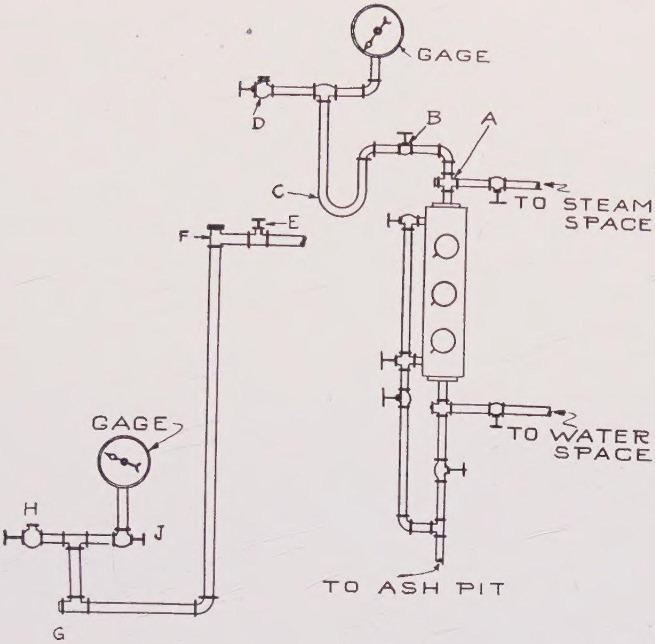

Fig. 1. Gage Connections Are Important Both for Accuracy and Safety.

As there is little danger of the connecting pipe clogging up it is not customary to blow out such lines except at long intervals.

It will be noted that the water seal extends up to F and is maintained at that level by condensate. As this adds a head to the gage reading, proper account must be taken of this in the calibration of gages so located. This can be done by setting the gage at zero with the valve E closed.

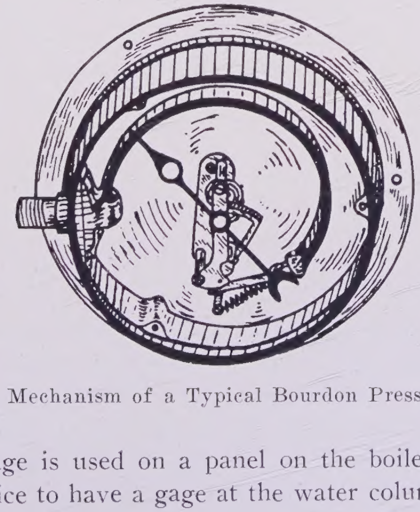

Fig. 2. Mechanism of a Typical Bourdon Pressure Gage.

Even where a gage is used on a panel on the boiler room floor, it is also considered good practice to have a gage at the water column.

Types of Gages

For purpose of indicating pressures, three general types of gages are employed, the Bourdon type, the diaphragm type and the manometer or U tube. Gages of the Bourdon and diaphragm types consist of two essential parts, the pressure element and the movement.

In gages of the Bourdon type, pressure is applied internally to an elastic hollow brass or steel tube of oval section, bent into the shape of a circular arc and closed at one end. Since the closed end of the tube is free to move, while the other end is fixed, fluid pressure on the inside tends to increase the short diameter of the section, causing the radius of curvature of the whole tube to become larger, thus moving the free end a distance proportional to the pressure applied. By connecting a suitable multiplying mechanism to the end of the tube a spindle or pointer may be moved so as to indicate on a graduated dial the pressure in the units desired.

Generally the multiplying mechanism is made up of one or more levers, a toothed segment or sector, a pinion and a hair spring. Adjustment of the ratio of movement between the pointer and the end of the tube is made by either a slotted sector rim or a connecting link, the length of which may readily be changed to suit conditions. Lost motion of the parts is taken up by the hair spring attached to the spindle carrying the pointer.

Owing to pointer vibration due to jarring which occurs in certain classes of service, also the rapid fluctuations of pressure sometimes encountered, double-spring gages are frequently employed. The pressure tubes in such a gage may consist of two separate branches or may be continuous; but in either case, there are two free ends, which, when properly connected by a lever mechanism, give a greater pointer movement than is obtained with a single spring.

In the diaphragm gage, the indicating device is actuated by a corrugated metal disk or diaphragm, clamped around its edges by the flame of an encircling chamber. The deflection of the diaphragm is proportional to be pressure applied to its lower side, and its movement is communicated to the pointer by a mechanism similar to that used in the Bourdon type.

Bourdon gages can be used for indicating pressures of liquids, steam or gases, where the tube does not reach a temperature much in excess of 150 deg. F., as above this limit the temper of the tube is likely to be affected. When used for steam pressures, therefore, a siphon must always be employed to prevent steam coming into contact with the tube, and should be of sufficient capacity to fill the gage tube with water.

Calibrating Pressure Gages

Gages may be checked for accuracy and calibrated by means either of comparison with a standard gage or the use of a dead-weight testing device, such as shown in Fig. 3. This tester consists of a stand from which rises a cylinder, having accurately fitted into it a piston with an area of 1.5 sq. in. which moves freely up and down. Attached to the top of the rod is a disk for the support of the weights; each weight is marked with the number of pounds pressure per

square inch that it will exert on the gage. From the bottom of the cylinder, two tubes project; one from a standard for holding the gage to be tested while the other, inclined, serves as a reservoir for oil and is fitted with a screw plunger.

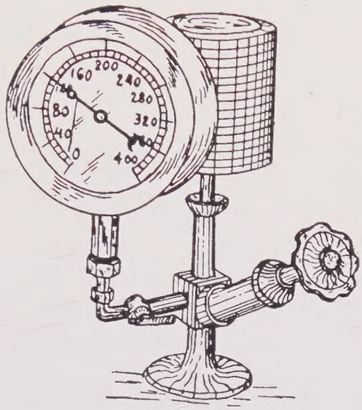

Fig. 3. Gages Are Usually Calibrated by Means of a Dead Weight Tester.

After the gage under test is attached and the three-way cock placed horizontally, the reservoir is filled with oil. This is done by turning the plunger inward to the extreme of its travel and pouring oil into the cylinder until filled; the plunger is then gradually withdrawn and at the same time more oil is added, continuing this until the plunger is in its outer position and with the cylinder nearly full.

With the cock under the gage open, the piston is inserted, which with its disk will indicate a pressure of about 5 lb. on the gage. The weights, one at a time, may now be placed on the disk which should be gently rotated to insure perfect freedom of motion to the piston. Each weight added will indicate a pressure on the gage equal to the number of pounds marked on it, and if the reading of the gage does not correspond to the total number of weights added, corrections of readings will have to be made for the error.

If, in testing a large gage, the piston descends to its full length, screwing in the plunger will force it upward, thus allowing the addition of more weight as may be required.

[W. E. S.]

Sugar Prices.

95° Centrifugals for the Period December 16, 1922, to March 15, 1923.

Date	Per Pound	Per Ton	Remarks
Dec. 27, 1922...	5.65	$113.00	Cubas.
" 29	5.59	111.80	Cubas 5.65, Porto Ricos 5.53.
Jan. 4, 1923...	5.53	110.60	Cubas.
" 6	5.46	109.20	Cubas.
" 8	5.40	108.00	Cubas.
" 9	5.31	106.20	Porto Ricos 5.28, Cubas 5.34.
" 10	5.34	106.80	Cubas.
" 11	5.37	107.40	Cubas 5.40, 5.34.
" 16	5.28	105.60	Cubas.
" 17	5.225	104.50	Cubas 5.24, 5.21.
" 18	5.085	101.70	Cubas 5.15, 5.02.
" 23	5.02	100.40	Porto Ricos.
" 26	5.21	104.20	Cubas.
" 31	5.26	105.20	Porto Ricos 5.24, Cubas 5.28.
Feb. 1	5.37	107.40	Cubas 5.40, Porto Ricos 5.34.
" 2	5.53	110.60	Cubas.
" 5	5.46	109.20	Porto Ricos.
" 6	5.53	110.60	Porto Ricos.
" 8	5.7133	114.266	Porto Ricos 5.65, 5.71, Cubas 5.78.
" 9	5.78	115.60	Cubas.
" 15	6.53	130.60	Cubas.
" 19	6.905	138.10	Porto Ricos 6.90, Cubas 6.91.
" 20	6.90	138.00	Porto Ricos.
" 21	7.155	143.10	Porto Ricos 7.03, Cubas 7.28.
" 23	7.28	145.60	Cubas.
" 26	7.095	141.90	Cubas 7.16, 7.03.
" 27	6.65	133.00	Cubas.
March 1	7.41	148.20	Cubas.
" 2	7.22	144.40	Cubas.
" 8	7.31	146.20	Cubas 7.28, 7.34.
" 12	7.41	148.20	Porto Ricos.